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OF

NATURAL HISTORY

EDITED

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THE SECOND DECENNARY OF THE AMERICAN NATURALIST.

IN entering upon the second decennial period of the existence of the American Naturalist, we may be pardoned for looking with some pride upon the success that has attended its establishment. If the reader will turn to the introductory words stating our aims in the first number, published in March, 1867, we think he will agree with us that the promises there given have been fulfilled as completely as could reasonably be expected.

Our aim has been to popularize the best results of the study of natural history, and thus serve as a medium between the investigator on the one hand and the teacher and student on the other. Thus, while we have attempted to inform the science-teacher of the latest discoveries in biology and geology in their broadest sense, including the theories of the origin of plants and animals, and the history of the earth and man, we have endeavored to attract and sustain the interest of the young. We know that a number of young naturalists have made their *début* in the scientific world in our magazine, while some of the most important results of the investigations of our leading scientists have first seen the light in its pages.

The progress in biology during the past ten years has been greater than is generally imagined. Text-books become superannuated within a decennary. Teachers and even working naturalists need the presence and stimulus of a monthly journal reaching beyond the limits of their specialties to keep them from nodding at their work. If we have failed to record all the new discoveries, it has been due in great part to lack of space.

We must again return thanks to our contributors, whose zeal and generosity have made the magazine what it is. From the first our articles have been given freely, out of love for the cause of science, and a desire for its free progress.

We have, in moments of discouragement and financial distress, felt sorely the want of proper material support from a people numbering upwards of forty-four millions, and of so much general intelligence and culture as ours; but so rapid has been the diffusion of science among the masses, even since the foundation of this journal, that we feel confident of ample support in the future. That the magazine has not been fully sustained pecuniarily may have been partly its own fault. Our critics tell us that it has not always been sufficiently "popular." We have endeavored to educate a public sentiment in behalf of the study of pure natural science for its own sake, and have sought to instruct rather than to amuse our readers. But the worst times, we trust, have been passed, and we confidently hope, with the new year we are entering upon and the encouraging auspices of the new arrangements begun last year with the present publishers, to excite a more decided enthusiasm among lovers of nature in the thorough success of a journal devoted to their interests.

As it is, the future of our journal is in the hands of persons of scientific culture. It is to the friends of liberal education, — to those who would advance the means of diffusing a knowledge of the methods of right thinking and working in science, which has still to encounter obstacles on all sides, from the ignorant and uncultivated as well as from even the cultivated *littérateur* or poet, trained in all directions except one, that of scientific modes of thought (witness Carlyle's late utterance respecting the theory of evolution), — it is to the friends of the best culture, which embraces scientific as well as classical and technological learning, that we would appeal for aid and support.

The study of science teaches us how to make nature minister to our wants. We learn the lesson from the study of nature that man's progress in intellectual grasp, and increase in moral force, have depended on the gradual improvement of his body. His mental and moral advance is in a ratio corresponding to his ob-

servance of the laws of physiology in its broadest sense. Right conduct is based on obedience to physiological and hygienic laws; and let us not forget that all future progress in the higher education of mankind is primarily dependent on the observance of scientific laws, especially those laid down by the biologist.

The intellectual and moral progress of man, all that is to emancipate him from the gross and materialistic forces of ignorance, bigotry, and prejudice — the outgrowths of the animal propensities he has, with little doubt, inherited from the lower orders of animals — is coördinated with his progress in the knowledge and application of physical laws. If his remote past is associated with reminiscences of the Amphioxus and Ascidians, the one lesson derived from a study of past creations and of existing life is the hope of a glorious intellectual and moral future for his race, and of his increasing capacity for appreciating the Infinite Power which, in a way at present unknown to his philosophy, guides the material and spiritual forces of the universe, and causes them to minister to his highest intellectual and spiritual development.

IS PROTECTIVE MIMICRY DUE TO NATURAL SELECTION?

BY ALFRED W. BENNETT.

IN the American Naturalist for September is an abstract of an article by that able naturalist, Fritz Müller, advocating the view that the curious phenomena of protective mimicry in Lepidoptera can be fully explained by the theory of natural selection. Notwithstanding the deference that is due to the conclusion of so eminent an observer, I have thought that the other side of the question should be heard.

I think it will be generally admitted that when we have a series of similar facts occurring throughout both the animal and vegetable kingdoms, an explanation should be sought that will cover the whole of these facts, while one which explains a portion of them only, but is obviously inapplicable to the remainder, should at least be looked on with suspicion and accepted with hesitation. Now external resemblances of a most minute kind between widely separated species both of animals and plants are

of very frequent occurrence, and, in a very large number of instances, are obviously not "mimetic" nor of any apparent service to the "mimicking" species. As a justification for this assertion, I may refer to a perfectly unexceptionable authority, namely, one of the best known advocates of the theory of natural selection, Mr. A. R. Wallace. In his inaugural address to Section D at the recent meeting of the British Association at Glasgow,[1] Mr. Wallace adduces the following illustrations of this law: "Our first example is from tropical Africa, where we find two unrelated species of butterflies belonging to two very different families (*Nymphalidæ* and *Papilionidæ*) characterized by a prevailing blue-green color not found on any other continent. Again, we have a group of African *Pieridæ*, which are white or pale yellow with a marginal row of bead-like black spots; and in the same country one of the *Lycænidæ* is colored so exactly like these that it was at first described as a species of *Pieris*. None of these four groups are known to be in any way specially protected, so that the resemblance cannot be due to protective mimicry." "In another series of genera, all belonging to the *Nymphalidæ*, we have the most vivid blue ground, with broad bands of orange-crimson on a different tint of blue or purple, exactly reproduced in corresponding yet unrelated species occurring in the same locality; yet, as none of these groups are protected, this can hardly be due to mimicry. A few species of two other genera in the same country also reproduce the same colors, but with only a general resemblance in the marking. Yet again, in tropical America, we have species of *Apatura* which, sometimes in both sexes, sometimes in the female only, exactly imitate the peculiar markings of another genus confined to America. Here again neither genus is protected, *and the similarity must be due to unknown local causes.*" Mr. Wallace adduces several other instances of a similar character; and even in the case of the very South American instances on which so much stress is laid by Fritz Müller, and, before him, by Bates, admits that "this can hardly be true mimicry, because all are alike protected by the nauseous secretion which renders them unpalatable to birds."

In the abstract of Fritz Müller's article it is stated that "Fritz Müller insists, as all writers on the subject have done, upon the similar geographical distribution of the imitating and the imitated species as a necessary concomitant of mimicry." If, there-

[1] See Nature, vol. xiv. page 403, September 7, 1876.

fore, it can be shown that species which would be called "imitating and imitated" if they occurred together are in reality found widely separated, it is obvious that this would materially weaken Müller's argument. Whether this is the case with Lepidoptera, I have not sufficient knowledge to state; but that accomplished entomologist, the late Mr. Edward Newman, assured me that in the case of some of the most remarkable instances of such resemblance known in this country, between particular species of Diptera and particular species of Hymenoptera, the resemblance is not associated with geographical contiguity. In the case of plants, at all events, I am prepared to state that resemblances as striking, which would certainly be considered illustrations of mimicry if they were found together and were of any apparent utility, do occur between species widely separated in space.

In the number of the *Popular Science Review* for January, 1872, appeared an article entitled Mimicry in Plants, in which I gave a number of illustrations of plants, or parts of plants, belonging to species widely separated according to any natural system of classification, and yet so exactly alike in their vegetative organs that they would deceive a practiced botanist. The resemblance extends in some instances not merely to general habit and appearance, but even to the arrangement of the veins. Dr. Berthold Seemann, no mean authority, speaks of having met in the Sandwich Islands with a variety of *Solanum Nelsoni*, which looked for all the world like *Thomasia solanaceà* of New Holland, a well-known Buttuereaceous plant of our gardens, the resemblance between these two widely separated plants being quite as striking as that pointed out in Bates's Naturalist on the Amazon "between a certain moth and a humming-bird."[1] In no one instance, that I am aware of, in the vegetable kingdom has protective mimicry been suggested as an explanation of this homoplasm. In most cases, as the one recorded above, the plants in question do not grow in contiguity.

But a more serious objection to the theory, that these remarkable resemblances are brought about by natural selection acting in the way indicated by Bates and Müller, lies in the difficulty of understanding how the first steps in the approach of one insect towards another could possibly be useful in deceiving an enemy. All the most cautious advocates of the theory, including Mr. Darwin himself, admit that "natural selection acts with

[1] Gardener's Chronicle, June 27, 1868.

extreme slowness;" and again that "only those variations which are in some way profitable will be preserved or naturally selected." By a train of reasoning founded on these two premises, I attempted to show, in a paper on The Theory of Natural Selection from a Mathematical Point of View [1] read before the British Association at the Liverpool meeting in 1870, that the chances against the required amount of change being brought about by this agency solely, are, on a hypothesis most favorable to the theory, say ten million to one; and I am not aware that the arguments there used have been met. Again, the purpose of mimicry is generally stated to be the perpetuation of the imitating insect, in consequence of deceiving its natural enemies by its resemblance to some species distasteful to them. If so, the purpose seems to have been somewhat inadequately fulfilled, even by the most perfect mimetism, as Mr. Bates and Mr. Wallace agree in stating, that, both in South America and the Malay Archipelago, the imitating species are always confined to a limited area, and are always very scarce compared with the imitated species.

Mr. Wallace, in his address to the British Association alluded to above, lays great stress on the probable influence of local conditions on the coloring and other external markings of animals, dependent on laws of which we are at present almost entirely ignorant. There can be little doubt that the instances of close resemblance in the vegetable kingdom of which I have spoken are due entirely to similarity of external conditions. When, therefore, we find similar phenomena in the animal world, it would appear more reasonable to attribute them to similar causes, rather than to refer them entirely to a hypothetical process like that of natural selection acting through protective mimicry, in which we are unable actually to follow two consecutive steps.

Mr. Mivart, in his Genesis of Species, and Mr. J. J. Murphy in his Habit and Intelligence have argued, much more forcibly than I can do, against the adequacy of natural selection to account for the phenomena in question; and, lest it may be thought that I am opposing the united view of all our best naturalists, I may remind my readers that so uncompromising an advocate of the theory of evolution as Professor Huxley has stated his deliberate conviction "after much consideration, and with assuredly no bias against Mr. Darwin's views, that, as the

[1] Nature, vol. iii. page 30, November 10, 1870.

evidence stands, it is not absolutely proven that a group of animals having all the characters exhibited by a species in nature has ever been originated by selection, whether artificial or natural." [1]

LONDON, *October* 4, 1876.

EDUCATED FLEAS.

BY W. H. DALL.

IN old-fashioned "annuals" and especially in obsolete works on instinct and intelligence among the lower animals, accounts of the so-called "Educated Fleas" will doubtless be remembered by my adult readers. The story of their marvelous performances had for my boyhood a peculiar interest not unmixed with incredulity. In later years I had begun half-unconsciously to class them with the spurious marvels of the "automatic chess player" and the generation of *Acari* by the action of electricity on chemicals. So far as my mind was occupied with the subject at all, it had concluded on general principles that intelligent action, of the kind described in the old works referred to, could be attributed to fleas with very little probability; and that, whatever the innate mental ability possessed by them, it was in the highest degree unlikely that it was susceptible of training.

Some weeks ago, when passing through Broadway, New York, not far from Union Square, an accidental glance caught the sign over a doorway, "Exhibition of Educated Fleas." Past memories and present curiosity determined me to make an inspection at once. Half an hour later I had seen all there was to see, purchased a lively little pamphlet by — shall I say the *inventor* of the educated fleas? and decided that the small fee exacted was well expended. As it does not appear that the *modus operandi* of this exhibition has ever been explained, an attempt in that direction may not be uninteresting to the readers of the Naturalist.

To make the explanation intelligible it will be necessary to begin with the conclusion, or in other words to first state the essential part of the explanation.

First, the fleas are not educated.

Second, all the performances which make up the exhibition may be traced directly to the desire and earnest efforts of the insects to escape. The means employed to give an appearance

[1] Lay Sermons, page 323 (English edition).

of intelligent action to these struggles are sufficiently ingenious.

In the first place, each flea is attached to some object in such a manner that it cannot free itself, while the movements of its legs and feet are not hindered or embarrassed.

This was explained by the proprietor. The surface of the insect is so polished that no cement will adhere to it when dry, and should a soft or waxy substance be used the insect dies very soon. (A probable cause of this might be the obstruction of the stigmata.) He stated that by tying a single silk fibre around the flea and knotting it on the dorsal side, a bristle, fine wire, or what not, may be cemented to the knot. I was not able to observe exactly where the fibre encircled the insect. This part of the process is the most delicate and difficult to perform.

The proprietor states that female fleas are solely employed by him, since the males are "excessively mulish and altogether disinclined to work." The fact that they are much smaller and weaker than the other sex is probably another and more important reason, and they are said to die in a few days when closely confined.

The first preparation for their task is stated to be as follows: the wild flea is put into a small pill-box with a glass top and bottom, revolving on an axis like a lottery wheel and forming a miniature treadmill. After a few days' confinement herein, the flea, which in a state of nature is, as we know, excessively inclined to jump, becomes broken of the habit. It is said that the constant raps which it receives, when attempting to jump and thereby hitting the sides of its prison, incline it to walk. If this be true, and it might readily be tested by experiment, the flea's education is entirely comprised in it, and, so far as it goes, it is a species of training. I am not yet convinced of the accuracy of the statement. A "wild" flea was shown, attached by one foot to a minute ball and chain, and certainly jumped continually. If a "tame" or educated specimen had been similarly weighted, and had showed no desire to jump, it would have indicated the truth of the theory, provided its legs were found to be sound. This, however, was not done, and all the "tame" ones, having something on their backs, might thereby be affected differently from one confined only by one "foot."

The performances may be divided into two classes: first, by fleas attached to a movable object; and second, by fleas attached to an immovable object. The former (with one exception) are

employed in pulling, pushing, or carrying some object about. This portion of the exhibition is a genuine exposition of the very extraordinary strength in proportion to its size, which is possessed by this little insect. Small and beautifully executed models of horse-cars, vessels, coaches, a wheelbarrow, butterfly, etc., are pulled about, each by a single flea attached firmly to a minute pole or wire, extending from or under the object. Small bits of silk, tissue paper or other light material are attached to the knot on the flea's back, and by courtesy are termed dresses, or equestrians as the case may be.

The proprietor states that the weight of a flea is about 0.05 of a grain, or, if well fed, 0.1 grain. He states that the model of the street car exhibited weighs one hundred and twenty grains or about twelve hundred times the weight of the flea which drags it. Whether these figures be precisely accurate or not, it is a very remarkable effort for so small a creature. Vigorous specimens are said to occur which are able to pull even a considerably larger weight.

The fleas from dogs are less strong than the human parasite, and require more frequent feeding. The ordinary flea will remain four days, it is said, without injury for want of nourishment, and will live for weeks, though diminishing in weight. They are said to live about a year; the performers average eight months, but one is recorded by the proprietor as having lived twenty-three months in his possession, the last two of which were passed in a state of great weakness.

It was noticeable that the surface over which the fleas dragged their burdens was composed of compact blotting paper on which their hooklets took good hold, and that whenever the performance of any one individual was not going on, the particular object to which it was attached was laid on its side, or so that the insect was left, feet in air, where it could not exhaust itself by unnecessary efforts. I think that the absence of any proof of education in the above cases is quite plain.

In the second class of cases the efforts made by the flea to escape are precisely the same, but, being fixed itself, it must necessarily show its power by traction upon some movable object or by aimless gesticulations in the air.

Generally the insect is attached to a sort of style or wire in a perpendicular position with the head uppermost and the limbs extended horizontally. Usually it will remain quiet, but if disturbed by the vibration of its wire, as produced by knock-

ing on the table, it will work its limbs about, seeking something to take hold of. If, then, segments of finest wire, fans of tissue paper, or other representations of objects in miniature are attached to its fore "feet," we shall have it apparently brandishing a stick or sword, fanning, performing on a musical instrument, etc., all of which is much more clearly seen with the aid of a lively imagination.

Two fleas furnished with segments of finest wire on their fore "feet," and placed with their ventral sides so near that the mimic swords can touch, but not the insects' feet, give a representation of a duel not much worse than that usual in most theatres. In their struggles to reach the adjacent object, it would be strange if the little wires did not clash occasionally.

"Madame Lenormand," "Rebekah at the Well," and a flea turning a miniature windmill are brought, each on its perch, so near an endless chain of ingeniously minute workmanship, that their hooklets catch in the links, and they eagerly seize the opportunity of pulling themselves, as they suppose, away from their bonds. The only result is that a little pointer turns to a number on a dial, a little bucket comes out of a well-curb, or the mill goes round. A similar but horizontally applied motion propels a little merry-go-round.

The most amusing and, at first, most incomprehensible of the various performances, is that of the dancing fleas. The orchestra are placed above a little music-box, whose vibrations cause them to gesticulate violently for a few moments, fastened as they are to their posts. Below them several pairs of fleas (fastened by a little bar to each other in pairs, those of each couple just so far apart that they cannot touch each other) are apparently waltzing; an inspection shows that the two composing each pair are pointed in opposite ways; each tries to run away, the "parallelogram of forces" is produced; the forward intention, converted to a rotary motion, ludicrously imitating the habits of certain higher vertebrates.

I have sketched the plan of the performance, and it will be noticed that there is nothing in it which cannot be explained on the hypothesis with which we set out, namely, that all the effects produced may be the result of the natural efforts of the insect to escape, the burden of proof being with those inclined to a contrary opinion. Whatever the result to our opinion of the flea's mental powers, one can hardly avoid admiring the ingenuity with which the "stage property" has been fitted to its purpose, and the beauty of the models and apparatus.

The exhibitor claims to feed his swarm on his own arm, which exhibited a sufficiency of punctures. His whole company may be packed into a shaving-box and put in his coat-tail pocket. He claims to have originated the exhibition forty years ago. Some of the anecdotes in his little pamphlet are amusing enough, and we find the following contributions to the Natural History of the Flea.

"The flea may be easily dissected in a drop of water, and by this means the stomach and bowels may be plainly discovered, with the veins and arteries" (!) Their "amazing motion is performed by means of the great elasticity of their feet, the articulation of which are so many springs, in accordance with the exalted and lofty aspirations of the insect." And finally, "Take a well fed — (*Cimex*) and a starved flea, and place them under a glass together, and you will be afforded an amusing spectacle. The flea as soon as he perceives the pursy condition of the bug will hop upon its back, and, in spite of the latter's struggles to throw him off, will succeed in extracting the blood from the bug's body, leaving it in quite a lean condition, while the flea becomes round, plump, and happy, after its beneficial ride."

THE GIANT BIRDS OF NEW ZEALAND.

BY I. C. RUSSELL.

OF the many remarkable additions that New Zealand has made to the various branches of natural science, none have attracted greater attention, or called forth more exclamations of wonder, than the remains of the giant birds that at no very distant day inhabited those antipodal islands.

In order that we may more fully understand the bearings and relations of our subject, let us glance for a moment at the present inhabitants of New Zealand, many of which are very strange and interesting. Aside from the aborigines, who are an offshoot of the ancient Polynesian family, the first feature that attracts our attention is the total absence of land mammals. The dog and a small species of rat are sometimes spoken of as being natives of New Zealand, but they more likely accompanied the aborigines in their wanderings, or were introduced by the earlier voyagers. The reptiles are almost as great strangers in those islands as are the mammals, being only represented by a few species of harmless lizards, which are very plentiful in individ-

uals, however, in many parts of the country. The position filled by the mammals in other lands is there occupied by the feathered tribes, which reached a surprising development, not only in the living, but more markedly in the extinct fauna.

New Zealand is geologically very old, and probably the remnant of a large continent that has now mostly disappeared beneath the sea; its connection with other lands seems to have been severed before the appearance of mammals on the earth. The birds being the highest form of life on the ancient continent, became concentrated on the remaining islands, which retained many unique and peculiar forms unknown in other portions of the globe.

Like all the islands of the southern hemisphere, the shores of New Zealand are visited by immense numbers of the widely-spread sea-birds, including the great albatross, the largest bird that flies. On the land there are many varied and beautiful forms, including, as in other countries, hawks, owls, pigeons, ducks, etc., together with a large number of smaller birds, as thrushes, starlings, and honey-eaters; among the last is found the beautiful tui or parson bird, as it is often called from the two tufts of white feathers on the throat. Besides these there are other remarkable birds, some of which are very poor of flight, and still others that are wingless, which are peculiar to New Zealand, and of special interest.

Among the numerous parrots the most curious is the kakapo, a large green bird, that, contrary to the usual habits of its tribe, lives on the ground, and, having very poorly developed wings, seldom takes to flight; as it is unable to escape from its enemies, or procure its food in the usual way, it remains concealed during the day in the crevices of the rocks, and is most active during the night.

The rails afford a number of interesting species, among which are the weka and the pukeko, as they are called by the natives; these were both very abundant at one time, but are now becoming scarce. The weka, or wood hen, is about the size of a common fowl, of a yellowish-brown color, and inhabits the forest and fern thickets. Its peculiarity is the almost total lack of wings, these being very rudimentary and useless for flight. The weka is the most common of the brevipennate birds of New Zealand, which approach in their habits the character of the lower mammals. The Notornis is another wingless rail, that is especially interesting, as but two individuals are known, which are supposed

to be the last of their race; one of these was captured on the west coast of the South Island and is now among the treasures of the British Museum.

The true wingless birds of New Zealand, however, are the kiwis, of which four species are known; all of these are totally incapable of flight, being, as their scientific name (*Apteryx*) implies, without wings; they have, however, the merest rudiments of wings, that can be felt underneath the feathers. The kiwis, although at one time quite abundant and used by the natives for food, are now the most unique and rarest birds in New Zealand and probably the strangest of living birds. The kiwis are small for the order to which they belong, the Cursores, which includes the ostrich, emu, cassowary, etc., the smaller ones being from fifteen to twenty inches high, while the largest, the roa-roa (*A. maxima*), is the size of a small turkey. They all have strong, well developed legs, depending on their speed for safety; and long bills, which they thrust among the decayed leaves and fern-roots in quest of the grubs and insects that constitute their food. Like the kakapo, they seek their food at night, as they are then exposed to fewer enemies. As is common with the cursorial birds, the kiwis have a loose, hair-like plumage of a dull brown or gray color. Being without wings or tail they have a very odd appearance, looking like a ball of feathers, to which are appended two stout legs and a long bill. We must not fail to notice the size of the kiwi's egg, which is monstrous when compared with the size of the bird, being about five inches in length and weighing usually over thirteen ounces, or one quarter as heavy as the parent bird. Like the other short-winged birds of New Zealand, the kiwis are fast becoming exterminated, not only by the natives, but also by their new enemies, the dogs, cats, and rats, that have accompanied the white man. Wherever the country has been settled by Europeans the kiwis have disappeared, and are now found only in the wild and little-known region along the west coast of the South Island.

Science in her survey of the earth has shown that, as with the trees and flowers, the various orders of animal life are grouped in distinct geographical provinces, in which certain types predominate. Not only does this grouping hold good for the animals of to-day, but embraces, also, the later geological ages, and shows that the ancient forms frequently far surpassed their modern descendants in size. Thus, in South America, where the little armadillos and the sloths have their home, the

geologist has brought to light the remains of the huge Megatherium, that exceeded the elephant in size, and other giant edentates, that inhabited the same land in Tertiary times. In the same marked manner the marsupials which inhabit Australia and Tasmania, to the exclusion of higher forms of life, were preceded by animals of the same structure, but greatly exceeding in size the kangaroo and the wombat of to-day. The same connection holds good between the living and extinct carnivores of Asia, and with the ruminants of North America. In New Zea-

(Fig. 1.) APTERYX AND DINORNIS OF NEW ZEALAND.[1]

land we find the little wingless kiwi preceded by a host of giants bearing the same general form, but whose ponderous frames approached that of the elephant in their development; huge wingless birds, many of them being ten or twelve feet in height, and far exceeding in size and strength the African ostrich, the largest of living birds. These giant birds, that surpass in strangeness the fabulous rocs of Arabian story, were plentiful in New Zealand at no very distant time, and are known to the natives as the moa, and have been grouped by science in two genera, *Dinornis* and *Palapteryx*.

[1] From Tenney's Elements of Zoölogy.

It was the writer's good fortune while stationed at Queenstown, N. Z., in connection with the United States Transit of Venus Expedition, to obtain some of the interesting remains of these huge birds from a cave that we discovered on one of the lower mountains overlooking Lake Wakatipu. Immediately back of Queenstown rises a hill, as it is called in that land of snowy mountains, over two thousand feet high; separated from Mount Ben Lomond by a deep narrow valley, the sides of which are very steep, in some places forming beetling cliffs that are inaccessible even to the wild goats. It was on the side of this narrow valley, eighteen hundred feet from the base of the hill, that the Moa Cave, as we named it, was found. Soon after arriving at Queenstown we heard of the existence of a cave on that portion of the hill and, procuring a guide, we visited it. This cave extended into the side of the hill for a distance of fifty or seventy-five feet, but we found little in it of interest, except a few feathers, which we believe on good authority to be those of the extinct moa, indicating that this cave was very likely inhabited at one time by that bird. Proceeding up the hill to search for other caves, we soon came to a long crevice in the rock, from two to three feet wide, the sides of which were overgrown with ferns; upon parting these and looking down, I could see the bottom of the cave, which descended obliquely, and there to my great delight I saw a large bone projecting from the dirt, some twenty feet below. I lost no time in descending the crevice and securing the prize, which I found to be a huge metatarsal bone of *Dinornis robustus*, measuring 17.5 inches in length, and 6.8 inches in circumference at the smallest portion of the shaft; on further search its companion was found, also a large portion of the tibia and some of the vertebræ of the same individual. Although careful search was made we were unable to find the remaining bones of the skeleton, and were at a loss to know what had become of them. These bones were all well preserved, and seemed to have lost a great part of their animal matter.

On continuing our exploration, we found that the cave first discovered joined another and still deeper one; into this we descended with the aid of a rope, and, groping our way along for about a hundred feet, were rewarded by finding more bones of the moa. In the extreme end of this cave and mingled with dirt, that had evidently fallen from above, we obtained a number of bones belonging to two or three individuals. As the cave at this point was quite narrow, the earth had to be carried back to

a wider portion, which, together with the small space in which to work, made the task difficult; we were rewarded, however, by finding a well-preserved femur of a smaller species of moa, probably *Dinornis didiformis*, and also a perfect sternum, perhaps belonging to the same skeleton, measuring seven inches in length by five in breadth, formed of a single strong, somewhat curved plate of bone, without any indication of a keel, thus forming a striking contrast with the strongly keeled sternum of the eagle and other birds of flight. The most interesting relics that were found in the cave were fragments of the egg-shell of these same birds; the largest piece was about five inches long by three in breadth, and but slightly changed by its long stay in the cave; these fragments were about the twentieth of an inch thick, and covered irregularly with punctures. The largest piece being placed upon an ostrich egg shows it to have belonged to a very much larger egg. A nearly perfect egg of the moa, discovered some years ago, was about ten inches long by seven in breadth, so large that "a hat would make a good egg-cup for it."

In addition, we found in our Moa Cave some small, slim bones which are probably portions of the skeleton of a kiwi; and also an imperfectly ossified bone, about an inch long, lying with the fragments of egg-shell; this we were inclined to think belonged to the "chick" that was once inside of the moa's egg, the fragments of which we had obtained.

The cave where these bones were found was one of a series of nearly parallel rents, that followed for some distance the base of a precipice some two or three hundred feet high, and had evidently been formed by the falling away of a portion of the hillside, which is composed of mica-schist. That the bones were introduced from above, either by being washed in, or by the birds falling into the crevices, seems evident, for the caves were too narrow and too difficult of access to be inhabited by a bird as large as the moa. That some of the bones fell from above is clearly shown by the fact, that one huge femur had been caught between the side of the cave and a fragment of rock which had fallen in but was too large to reach the bottom; this bone was held so firmly that it was with considerable difficulty we secured it.

There is little doubt that the moa roamed over those mountains after they had received their present form, and the finding of their remains in such an inaccessible place, shows that huge as those birds were, they yet possessed considerable activity, for

it was no easy climb, even for a person accustomed to the work, to reach our moa cave. We also heard of a cave in which moa bones had been found, at a still greater elevation among the Hector Mountains, on the east shore of Lake Wakatipu. Other moa bones were obtained from a cave, but a few feet above the waters of the lake and lower than some of the lake terraces.

The former existence of gigantic birds in New Zealand was first made known in 1839, when a few fragments of their remains found their way into the hands of scientific men in England. Not long afterwards, Mr. Walter Mantell made his well-known discovery of moa bones on the east coast of the South Island. This extensive collection passed into the possession of the British Museum, and furnished Professor Owen with the material for his splendid study of these remains, which were grouped under two genera, *Dinornis* and *Palapteryx*, and these again subdivided into numerous species. The specific distinctions are somewhat difficult to trace, as the bones vary in size; the smallest metatarsal bone in our collection measures 7.5 inches in length and 3 inches in least circumference, while the corresponding measurements of the metatarsal bone of *Dinornis giganteus* are 18.5 and 5.5 inches respectively, — the tibia of the same bird being three feet in length; between these limits there is an almost complete gradation in the size of the species.

In later years numerous discoveries of these remains have been made, both on the North and South Island, and from deposits along the shore that are swept by the tides, to an elevation of five thousand feet or more amid the Southern Alps.

One of the most remarkable deposits yet discovered was at Hamilton, Otago, where from an area of about seven hundred square feet, three and one half tons of moa bones were obtained, for the Otago Museum. As a great number of bones were too much decayed to be collected, this amount indicates only about one half of the total quantity contained in this limited deposit. These bones were found literally packed down in bulk, entirely separated from each other, and mixed indiscriminately throughout the deposit. The place in which they were found seems at one time to have been a lagoon surrounding a spring, to which the moas resorted in great numbers, the bones of those that died being scattered and trampled down by the living birds. Together with the moa bones were found the remains of an extinct goose, and also of an eagle that once lived in New Zealand. The reason for the moas collecting and dying in such numbers at this

one locality is obscure; it has been suggested by Mr. Booth, the discoverer of the fossils, that it was owing to a refrigeration of climate, the birds collecting in this spring for warmth as the winters became more cold. Dr. Hochstetter also obtained, during his visit to New Zealand, valuable moa skeletons from limestone caves in the South Island. These skeletons were found beneath deposits of stalagmite, and were entire, showing that these birds inhabited the caves and had retired there for refuge when death overtook them. Together with these skeletons the ossified rings of the trachea were found, and also little heaps of smoothed pebbles, "moa-stones," which had been swallowed by the moa to assist digestion, in the same manner as the domestic fowl swallows sand and gravel.

The remains of these gigantic birds are not only found in caves and recent river deposits, but also scattered over the surface of the country; although it is somewhat uncommon to find them thus exposed at the present time, yet in the early days of the colonists they were quite abundant, and the little heaps of "moa-stones" were frequently found beneath the ferns. Some years since Dr. Hector observed, near Lake Wakatipu, over thirty skeletons of the moa lying at the foot of a cliff, in the shelter of which they seem to have sought refuge from the storm that destroyed them.

Remains of moa bones, and also fragments of the egg-shells of the same birds have been found, showing the action of fire, and mingled with the charred bones of men and dogs in the ancient kitchen-middens of the New Zealanders. The large bones are also found broken open as if to obtain the marrow; and the egg-shells have been found in the graves of the aborigines. Many other facts have been brought to light by the scientific men who have labored in New Zealand, proving that the moa still existed on those islands after their settlement by man, who introduced a new and higher element into the "struggle for existence" that resulted in the extermination of the moa.

There is but little doubt that the moa, which was once so abundant in New Zealand, furnished the principal food of the natives as they increased and occupied the land. This is the more evident when we remember that those islands furnish little that is sufficiently nutritious to serve as food for man. Nothing like the delicious berries and larger fruits that abound in our own country are found in New Zealand. The food of the natives, at the time of the discovery of those islands, was confined to a kind

of sweet potato, which they had brought with them in their emigration, the succulent root of a fern (*Pteris esculenta*), which, although abundant, is exceedingly indifferent food, together with shell-fish. To these were added the flesh of birds, especially of the "mutton bird" (*Puffinus tristis*), and of seal and fish; then, too, the scanty board was filled out with human flesh. It is not without reason, therefore, that a bird so large, and furnishing so much food as the moa, should be eagerly sought after by the Maoris, and, being unable to fly, and unlike the ostrich, having no desert to flee to, soon became extinct.

The suggestion of Hochstetter that it was only after the extermination of the moa, and the consequent scarcity of animal food, that the New Zealanders were driven to cannibalism, is full of significance.

There are uncertain indications that New Zealand was inhabited by an older people than the present aborigines, a race of "black fellows," as the Maori traditions state, who were exterminated by the more warlike Polynesians. Some consider this older race as the true moa hunters, who exterminated those giant birds many hundred years ago; the active search that is now being made in the ancient cave dwellings of New Zealand, it is expected, will throw more light on this interesting subject.

The adventures of the New Zealand moa hunters, armed with spears and implements of stone, to whom the use of the bow was unknown, must have equaled in wildness and danger the struggles of the Neolithic hunters of Europe with the cave bear or the fierce aurochs. What wild, weird scenes those deep valleys of the Southern Alps must have witnessed, when, after the successful hunt, the natives gathered about their camp-fires, that lit up their dark tattooed faces and shone on the strange vegetation around, to feast on the flesh of the moa, or partake of its huge eggs, roasted on the hot stones of the oven!

How long these birds have been extinct is as yet unsettled. The fact that the bones are found so plentifully, often lying exposed on the surface of the ground, and also the fresh condition of many of the remains, some of which still retain the dried muscles and feathers attached, show that the moa lived at a very recent date, geologically speaking. The Maoris, however, with whom we conversed while in New Zealand, although some of them were cannibals in their youth, had never heard of these birds as living, not even through the traditions of their ancestors. Some of the old legends of the natives, still extant, do contain,

however, references to the moa; it is stated that their long plumes excelled in beauty the crest of the white heron, which is so highly prized by the Maoris.

That the moa not only inhabited New Zealand in great numbers, but also exhibited great variety among themselves, is shown by the differences in the size of the vast number of remains that have been collected. While the larger bones of *Dinornis elephantopus* were short and exceedingly thick and ponderous, the femur measuring nearly eight inches in circumference at the smallest portion of the shaft, the corresponding bones of *D. gracilis* were longer and comparatively slim, indicating a bird of more elegant proportions. The largest of the moas, *D. giganteus*, that stood full ten feet high in its natural position, and could reach to a much greater height, presents a great contrast to the smallest of these birds with which we are acquainted, which could not have been taller than a large turkey.

We have but to greatly exaggerate in our fancy the general form of the wingless and tailless kiwi, to have an accurate idea of their ancient representative. The moa was not furnished, however, with the long, slim bill that the kiwi uses so adroitly in probing the earth in quest of worms, but possessed a much shorter and stronger bill, indicating a more strictly vegetable diet. Its principal food was, probably, the root of the *Pteris esculenta*, which it could easily tear up with its powerful claws.

Besides the various species of Dinornis and Palapteryx, the remains of numerous other fossil birds have been found, not approaching these in size, however; they include species of Apteryx, penguin, albatross, parrot, goose, etc., showing that the feathered tribes have long been the rulers in New Zealand.

During the past few years so much interest has been taken in these fossils that they have found their way into nearly every public museum in the world. Next to the colonial museums of New Zealand, the finest collection of moa skeletons is to be found at the American Museum in Central Park, which consists of a large number of mounted skeletons of different species, including the giant of them all, the *Dinornis giganteus*, the skeleton of which stands about ten feet high; this colossal bird, if living and striding along the muddy shore of some sheltered bay, would leave tracks in the mud as huge as those which excite the wonder of the geologist from the triassic sandstone of Connecticut and New Jersey. Other skeletons of the moa may be seen at the Smithsonian Institution in Washington, and in the Geological Museum of the School of Mines, Columbia College, New York.

While considering the extinct birds of New Zealand, it may not be uninteresting to our readers to turn their attention briefly to the island of Mauritius, the home of the dodo, which is situated about a thousand miles eastward of the coast of Africa, and together with its associated islands presents many features analogous to the life of New Zealand. The Dutch navigators, while making their earlier voyages to the Indies by the new passage around the Cape of Good Hope, found on this uninhabited island large numbers of the clumsy, wingless birds that have received the name of the dodo. This bird which was related in structure to the pigeons, was of about fifty pounds in weight; being totally incapable of flight and very clumsy, it fell an easy victim to the sailors, who killed it in great numbers. Owing to the persecution of man and also, probably, to the depredations of the animals that accompanied him, the dodo soon became exterminated. The only records of its existence which remain are a few of its bones, and the rude drawings and descriptions in the books of the Dutch navigators, together with two or three pictures supposed to have been painted from life. The dodo furnishes the best-known example of the extermination of a species through the agency of man.

Those who would place the extinction of the moa so far in the past will do well to consider the case of the dodo, that, as we have seen, abounded on its native island scarcely two centuries ago, but of which we now know but little more than we do of the moa.

Madagascar, also, had its huge wingless bird, the Æpyornis, that equaled or even exceeded in size the largest of the moas. On the island of Rodriguez another colossal bird, the solitaire, was found, which, like the dodo, has been exterminated by man, and the same fate has befallen other allied birds on the Isle of Bourbon.

It is remarkable that all these huge wingless birds, including also the ostrich and the rhea, are confined to the southern hemisphere, and still more strange that so many of the largest and most interesting of them should be found only on the widely-separated islands of the Indian and Pacific oceans. When and how they came to those isolated islands, or from what ancient forms of life derived, can only be known when the caves and recent rock formations of those islands shall have been explored, and the fragments of the ancient history of these beings deciphered and translated by the geologist.

THE MIGRATIONS OF THE DESTRUCTIVE LOCUST OF THE WEST.

BY A. S. PACKARD, JR.

THE following remarks concerning the probable causes of the migrations of the western locust are extracted from a forthcoming report on this and other injurious insects in Prof. F. V. Hayden's Annual Report of the United States Geological and Geographical Survey of the Territories for 1875. The facts and theories were in part suggested by observations made by myself in Colorado, Utah, and Wyoming, in 1875, while attached for a few weeks to the Survey, and in part by the reports of Prof. C. V. Riley, State Entomologist of Missouri, and by the statements of Prof. Cyrus Thomas, State Entomologist of Illinois, and Hon. W. N. Byers of Denver, and others.

In dealing with this fearfully destructive insect, which has attracted so much notice from the public, and in seeking for remedies against its devastations, it is of prime importance to have a thorough knowledge of its breeding places, the frequency and extent of its migrations, and to seek for the connection between the direction of the winds and other meteorological phenomena, and the flights of the locust.

The locust is quite or nearly as destructive in Africa, Asia, and Southern Europe, as in this country, but the laws of their migrations and their connection with meteorological phenomena have never been studied in those regions, and it remains for the United States, with its Weather Signal Bureau, to institute in connection with the scientific surveys of the West investigations regarding the nature of the evil, and the best means to overcome it.

In endeavoring to trace the connection between the migrations of the locusts and the course of the winds at different months, the writer has been led into some theoretical considerations which seem to be supported by the facts presented in the unpublished report, and which may be confirmed or disproved by future investigations.

History of the Migrations of the Locust. — The following table, compiled from the reports of A. S. Taylor, the late Mr. B. D. Walsh, Prof. C. V. Riley, Prof. C. Thomas, Mr. G. M. Dawson, and the observations of Mr. W. N. Byers, will show the years when the locust was excessively abundant and destructive in the different territories and states, and also serve to roughly indicate the frequency and extent of the migrations of the destructive lo-

cust of the West. The dates which are starred are years when the progeny of the locusts of the preceding year abounded, and when in most cases there were no fresh incursions from the westward. The species referred to under the head of California, Washington, and Oregon may be some other than *Caloptenus spretus*.

Manitoba.	Minnesota and Western Iowa.	Montana and Dakota.	Wyoming and Idaho.	Utah.	Colorado.	Nebraska, Kansas, and Western Missouri.	Indian Territory and Texas.	California.	Washington and Oregon.
1818	1818								1827 or '28
1819	1819								1834 or '35
	1820					1820 or '21		1838	
			1845				1845		
						1846 ?			
			1852	1852			1849		1852
	1855	1855 ?	1855 ?	1855	1855?	1855	1855	1855	1855
	1856*			1856*			1856*	1856*	
1857				1857					
1864	1864	1864			1864				
					1865*				
						1866	1866		
1867	1867			1867	1867	1867	1867		
1868*				1868*	1868	1868*			
1869						1869*			
1872									
	1873	1873	1873	1873?	1873			1873	
1874	1874	1874	1874		1874	1874	1874	South.	
?	1875	1875	1875		1875*	1875*	1875	Cal.	
	1876	1876	1876		1876	1876	1876		

This table and the data on which it is based are necessarily very imperfect, owing to the vast extent of the territory over which the locust swarmed, and the fact that the greater portion is uninhabited, while the inhabited portions have been settled only within comparatively few years.

The Theory of the Migrations. — (1.) *The immediate cause of the migrations of the locust from its original breeding places is the unusual abundance of the species during certain years.* It has been found in some cases that the exceptional years when the locust migrates are periods of unusual heat and dryness, conditions unusually favorable to the excessive increase of insect life. As may be seen in the accounts of the eastern locust, the grass army worm, the grain aphis, the chinch bug, and other less destructive insects, when the early part of the season, the spring and early weeks of summer, are warm and dry, without sudden changes of temperature, insects abound and enormously exceed their ordinary numbers. When two such seasons occur, one after the other, the conditions become still more favorable for the undue

development of insect life. Now it is well known that in the Eastern States the summers of 1860 and 1874, preceding the appearance of the army worm and grain aphis, were unusually warm and dry, and favorable not only for the hatching of the eggs laid the year previous, but for the growth and development of the larvæ or young. Look now at the conditions for the development of locust life on the hot and dry plains, chiefly of Dakota, Montana, Wyoming, and Idaho. We have no meteorological records from these regions at hand, but it is more than probable that the years preceding the migrations of the locusts were exceptionally warm and dry, when the soil was parched with long-sustained droughts, as we know that the corresponding species east of the Mississippi River abounds during dry summers following dry and warm springs.

Given, then, the exceptional years of drought and heat and the great extent of territory, and we have as the result vast numbers of young hatched out. The year previous having perhaps been warm and dry, the locusts would abound, and more eggs than usual would be laid. These would with remarkably few exceptions hatch, and the young soon consume the buffalo grass and other herbage, and move about from one region to another, following often a determinate course in search of food. In this way large broods may migrate a long distance, from perhaps twenty to fifty miles. In about six or seven weeks they acquire wings. Experience shows that the western locust as soon as it is fledged rises up high in the air, sometimes a thousand feet or much higher. They have been seen to settle at night on the ground, eat during this time, and towards noon of the next day fill the air again with their glistening wings. As more and more become fledged, the vast swarm exhausts the supply of food, and when the hosts are finally marshaled, new swarms joining perhaps the original one, the whole swarm, possibly hundreds of miles in extent, begins to fly off, borne by the prevailing westerly and northwesterly winds, in a general easterly and southeasterly course.

(2.) *The secondary cause of the migration is the desire for food, and possibly the reproductive instinct.* The fact that in their migrations the locusts often seem to select cultivated tracts, rapidly cross the treeless, barren plains, and linger and die on the prairies and western edge of the fertile valleys of the Missouri and Mississippi, indicate that the impelling force is due primarily to the want of food, and that the guiding force is the direction

of the prevailing winds, for they have no leaders, and we do not believe in the existence of a "migratory instinct" in the locust any more than in the grass army worm, or the cotton army worm, which it is sufficiently evident migrate from field to field, simply in search of more abundant food. Meanwhile the reproductive system of the locusts is maturing, the eggs ripening, and the uneasiness of the locusts during the course of their travels may be unconsciously stimulated by the sexual instincts and the desire to discover suitable places for egg-laying, a long and tedious operation.

It has been sufficiently shown that a swarm of locusts observed by Professor Robinson near the entrance to Boulder Cañon, Colorado, traveled a distance of about six hundred miles to Eastern Kansas and Missouri. Though the swarm was first observed at some distance north of Denver, Colorado, it was then on its way from the north, and may have come from some part of Wyoming two or three hundred miles northwestward or northward. Though the winds may vary, and counter-currents exist, and storm-gusts from due north, such as often sweep over the plains, and local southerly breezes may retard their flight, the course is either eastward or southeasterly. We know enough of the winds in the Western States and Territories to lay down the law that the general direction of the winds in July and August, along the eastern slope of the Rocky Mountains and on the plains, is from the west and northwest, and accords with the eastward course of the locust swarms. The relations between the average direction of the winds and the migrations of the locust have, however, never been sufficiently studied, either, so far as we are aware, in Europe or in this country. And yet if we would intelligently study the causes of the excessive increase and migrations of the locust, we must examine the meteorological features of the country, ascertain the periods of drought and undue rain-fall, the average direction of the wind for the different months, in order to learn how far they correspond with the phenomena of insect life. That there are meteorological cycles, dry and hot seasons recurring at irregular intervals, while the general average may remain nearly the same century after century, is supported, though it may be vaguely, by observed meteorological facts.

The question then arises; *Can meteorologists predict the coming of seasons of undue heat and drought? and consequently can we predict insect years? that is, the migrations of locusts and the undue increase of the chinch bug, and army and cotton worm?* I

believe that we shall, after the lapse of years, be able to foretell with a good degree of certainty locust invasions, and be able to provide against the losses thus incurred.

On the frontier of the Western States, in Colorado, or in the Territories of Wyoming, Montana, and Utah, where the losses from the ravages of the locust cannot easily be made up by importations from contiguous territories, it seems the most practicable mode to provide in years of plenty against years of want. We should imitate on a grand scale the usage of the ancient Egyptians under Pharaoh, who laid up in times of unusual harvests stores of grain for times of famine. It is said that this has been done on a small scale by the Mormons. If this were done in the far West, in seasons immediately preceding insect years, which had been predicted by entomologists in conjunction with the meteorologists, we should be saved the distress, destitution, and even loss of life from starvation, which have resulted from ignorance of the laws regulating the appearance of destructive insects, especially the western locust.

The Return Migration.— By simultaneous observations for a number of years over the region liable to be visited by migratory hordes of locusts, added to the knowledge we already possess, it will not only be possible to predict the course of certain swarms from their breeding-places, and their probable destination, so that when a swarm starts from Montana or Wyoming, its arrival in Colorado a week or a fortnight later may with some certainty be predicted, and again, its arrival in Kansas and adjoining States be announced with a certain amount of precision, as has already been done by Dr. Riley, but we shall be able to foretell the course taken in the return flight of their progeny in the succeeding year. I will confess that previous to my visit to Kansas and Colorado, in 1875, I was skeptical as to Dr. Riley's opinion that there was a general movement in a northwest course of the young of the previous year, broods from Missouri and adjoining regions northwestward. The facts and resulting theory have already been stated in full by Dr. Riley and others. It remains to determine the causes of this return migration, this completion of the "migration-cycle," as Professor Dawson terms it. It is evident that in this case the desire for food is not the cause, for food is many times more abundant in the Mississippi Valley than on the plains whither they return. The solution of the problem, I think, must be sought in the direction of the prevailing winds during the middle of June, the time when they become winged.

It may be found after a series of careful meteorological observations, that the prevailing winds at this early season are southerly and southeasterly. It has been shown by meteorologists, as I learn from Prof. C. Abbe, that during May and June the winds blow inwards towards the heart of the continent from the Atlantic Ocean and Gulf of Mexico. On application to Gen. A. J. Myer, Chief of the Signal Service of the United States Army, for the meteorological data necessary to confirm this hypothesis, I promptly received a full summary of data observed by the officers of the Weather Signal Bureau, for periods of from two to five (usually the latter) years between 1871 and 1876, which show that the prevailing winds in June, in Davenport, Dodge City, and Keokuk, Iowa; Saint Paul and Breckenridge, Minnesota; Yankton and Fort Sully, Dakota; Omaha, Leavenworth, and Fort Gibson, Indian Territory, — all within the locust area, — are from the southeast and south. This fact may be sufficient to account for the prevailing course of the return migrations of the locust from the eastern limits of the locust area.

Let us therefore grant this setting-in of southerly and easterly winds, which may last until the locusts are winged. When they rise on the wing into the air they are known to move in a general northwest direction. It is highly probable that they are borne along by these generally southeasterly winds, and pass over on to the plains. The cause is seen, then, to be entirely independent of subsistence; possibly the reproductive instinct causes them to become uneasy, restless, to assemble high in the air and seek the dry, hot, elevated plateau of the northwest. Should this be so the cause of their migrations is probably purely mechanical. Abundant testimony is at hand to show that they are wholly at the mercy of the prevailing winds, and that as a rule the course of their migrations is quite dependent on the direction of the winds, while the course of the winds depend more or less on the season of the year. We may expect that future research over sufficient territory will show that the June migrations, from the eastern limits of the locust area, will be towards the northwest, and the July, August, and early September migrations, from the Rocky Mountain plateau, will be in a general easterly and southeasterly direction.

It is not only of great scientific interest, but of high practical importance, to collect all facts bearing on the return migrations, in order to know where the locusts go in their return migrations the second year, as we only know that they do fly a certain dis-

tance northwestward. We want to ascertain the extreme western limits of this return migration. We also want to learn whether they return to their original breeding-places on the eastern slopes of the Rocky Mountains, or whether the westerly winds, if they are westerly, drive them back and scatter them, so that they do not breed extensively.

It will be seen by the reader that all grounds for a reliable working theory of locust migrations are based on the work of our Signal Bureau and local observers, and that the observations of the meteorologists and entomologists must go hand in hand. The government has provided a well-organized corps of meteorological observers, and we submit that a number of competent entomologists should take the field, under government auspices. Not only should the border States, especially Texas, Kansas, Nebraska, Minnesota, and Iowa, employ competent entomologists, following the liberal policy of Missouri, which for eight years has had a state entomologist, whose reports have proved of incalculable practical value, as well as of great scientific interest, but the habits of the locust need first of all to be thoroughly studied in the Territories, particularly those of Wyoming, Montana, Idaho, Dakota, Utah, New Mexico, Arizona, and in the State of Colorado. A commission of entomologists should be appointed to make a thorough detailed study for several successive seasons of the habits of the locusts in the Territories mentioned. It would seem that the recommendations made at the recent meeting of Western governors at Omaha, that an appropriation be made by Congress, and a commission be attached to the existing United States Geological and Geographical Survey of the Territories, is the most feasible and economical method of securing the speediest and best results.

Let us for a moment look at the losses sustained in the United States from the attacks of insects. The annual agricultural products of this country by the last census amounted in value to $2,500,000,000. Of this amount we in all probability *annually* lose over $200,000,000 from the attacks of injurious insects alone. Dr. Riley avers that the losses during 1874 in Missouri from locusts, and it will be remembered that only the western third was invaded, exceeded $15,000,000. This would make the losses in other parts of the West at least twice as much more, or $45,000,000 in all. The estimated money loss occasioned by the chinch bug in Illinois in 1864 was over $73,000,000; in Missouri in 1874, it is estimated by Dr. Riley to have been

$19,000,000. The annual losses from the chinch bug are greater, Mr. Riley says, than from any other insect. The average annual loss to the cotton crop from the attacks of the cotton army worm alone is estimated at $50,000,000. Adding to these the losses sustained by the attacks of about a thousand other species of insects which affect our cereals, forage and field crops, fruit trees and shrubs, garden vegetables, shade and ornamental trees, as well as our hard and pine forests, and stored fruits, and it will not be thought an exaggeration to put our annual losses at $200,000,000. If the people of this country would only look at this annual depletion, this absolute waste, which drags her backward in the race with the countries of the Old World, they might see the necessity of taking effectual preventive measures in restraining the ravages of insects. With care and forethought based on the observance of facts by scientific men, we believe that from $50,000,000 to $100,000,000, or from one quarter to one half of this annual waste, could be saved to the country. And the practical, most efficient way is for the States to coöperate with the general government in the appointment of salaried entomologists, and of a United States commission of entomologists, who should combine the results of the state officials, and issue weekly, or, if necessary, daily bulletins, perhaps in combination with the Weather Signal Bureau, as to the conditions of the insect world, forewarning farmers and gardeners from week to week as to what enemies should be guarded against and what preventive and remedial measures should be used.

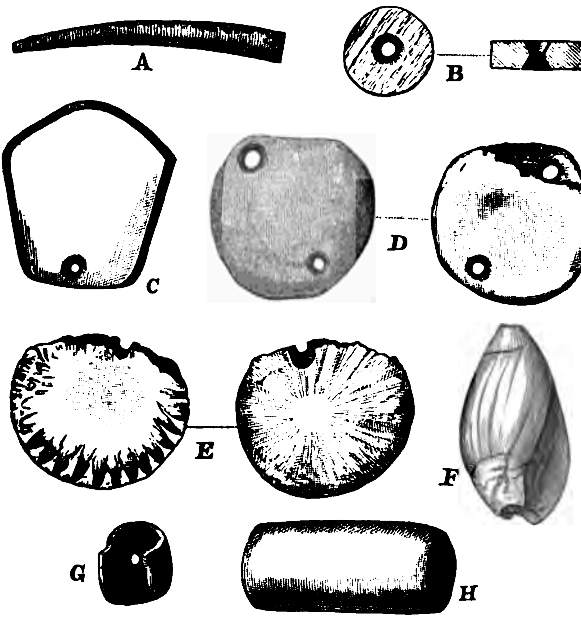
The Weather Signal Bureau, first suggested and urged by the late I. A. Lapham, was not instituted without ridicule and opposition, but it has saved millions to our commerce and agriculture. The maintenance of an entomological commission and the appointment of state entomologists would involve comparatively little expense. Already, owing to the full information regarding the invasion of Missouri by the locust in 1874, contained in the reports of Prof. C. V. Riley, the people of that State will be well prepared from the direful experience of the past, to deal more intelligently and efficiently with the locust in the future.

NOTES ON THE ABORIGINAL MONEY OF CALIFORNIA.

BY LORENZO G. YATES.

THE material used by the aborigines of California for purposes of exchange, and as media of circulation, are shells of mollusca, and rocks made into forms generally resembling beads or buttons. The *Dentalium* (Figure 2, A) is used by the Indians of the north. Large numbers have been imported from Europe for trade with the Indians.

The shell of *Saxidomus aratus* Gld. or "clam-shell," is broken into pieces of suitable size, and worked into flat circular

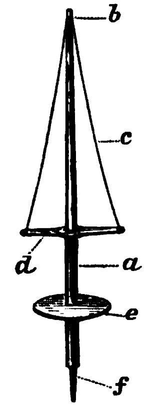


(FIG. 2.) ABORIGINAL MONEY OF CALIFORNIA.

disks, by rubbing upon a flat sandstone rock (which at some of the "Rancherias," or settlements, has to be brought from some distance). A hole is drilled through the centre and when finished (Figure 2, B) they are strung on strings. Among the Indians of Lake County eighty of these disks are valued at one dollar. The drill stock is formed as follows. (See Figure 3.) The shaft is about thirty inches long and formed of a straight stick somewhat tapering, *a*, about three fourths of an inch in diameter at the bottom or larger end. A hole is made through the upper end of the shaft, *b*, through which is passed a buckskin string about

three and a half or four feet long, *c*, the ends of which are fastened to the ends of a cross-bar, *d*, about eight inches long, in the centre of which is a hole through which the shaft plays easily. A circular wooden disk, *e*, serving as a fly-wheel, is fastened on the shaft about four inches from its lower end.

In using the drill, which is inserted in the lower end of the shaft, *f*, the loose cross-bar (to the ends of which the buckskin string is fastened) is twisted around the shaft a few times, the drill placed in position, the fingers of the right hand resting on the loose cross-bar, *d*, and on both sides of the shaft, *a*, when, by a quick downward pressure on the cross-bar the shaft is made to revolve, and receive sufficient impetus to *untwist* the string from the shaft, and twist it around in the opposite direction, rotating the drill to the right and left, the holes being drilled from both sides.



(FIG. 3.) DRILL.

The shell of the "abelone" (Haliotis) is formed into pieces resembling "key-stones" (Figure 2, C) and circular disks, plain as in Figure 2, D and ornamented as in Figure 2, E; these appear to be used also as ornaments for baskets, and worn on head-dresses, necklaces, etc.

The shell of *Olivella biplicata* Sby. is also (or was) used as money, the writer having found them occasionally in the "mounds" of Contra Costa and Alameda counties, mixed with the small flat disks described above.

They were made, first by rubbing the apex of the shell on a stone until a hole is made large enough to receive a string which is passed through the shell parallel with its axis (Figure 2, F); or by breaking the shell and using the pieces of the larger whorl, in the same manner as the disks made from the Saxidomus. (Figure 2, G.)

The "Gold Coin" of the aborigines is a long bead made of a peculiar kind of rock, the locality of which is kept secret by the Indians; it appears to be a magnesian silicate, beautifully banded or mottled; the colors being white, brown, and yellowish, the former color predominating. The writer having been unable to obtain even a fragment in its natural state, all the specimens seen having been subjected to the action of fire, either before being worked out, or previous to being polished, does not feel satisfied as to its mineral character. The money made from this material is of a cylindrical form (Figure 2, H), about three fourths

of an inch in diameter, and from one to three inches in length, with a hole drilled through lengthwise. They represent a money value of from $2.50 to $25.00, according to their length and beauty of finish and coloring. From the hardness of the material and the rough tools with which they are made, their manufacture must require a great deal of time and patience.

While exploring a mound in Contra Costa County several years ago, the writer found the charred remains of a human skeleton some two feet below the original surface of the soil under the mound, and with it a large and elaborately worked pestle, with a number of coins or beads similar to Figure 2, G mixed with red paint, and fragments of others similar to Figure 2, H. The body had evidently been burned with the beads, and the pestle purposely broken into several pieces; nothing else was found with the remains, except fragments of charcoal mixed with the surrounding soil.

The Indian females wear all the money they can command on the occasion of a "big dance" or other public gathering; but during a visit to the Lake country some years since, the writer had an opportunity of examining a common trunk filled with money and ornaments belonging to a squaw, who was married to a white settler (a common occurrence in that country); the inspection was made without the knowledge of the owner, who would probably have objected to it; the larger portion of the contents of the trunk consisted of money like Figure 2, B with a few like Figure 2, H interspersed.

THE PHILOSOPHER'S STONE.[1]

BY WILLIAM E. HAGEN.

A REVIEW of the history of alchemy will show that the effort made by it to produce gold artificially may be understandingly connected with certain phenomena found associated with gold in nature, and which may be reasonably supposed to have suggested such an undertaking.

From the early authors of Hellenic literature investigation first learns of alchemy as a pursuit of man, and as originating in ancient Cushite Arabia, amongst a people who had then been famed for great wealth in silver and gold for many ages, and of

[1] Abstract of a paper read before the Troy Scientific Association, February 21, 1876.

whom we are told that they had possessed the art of making gold from the earliest times. While we may look with wonder at the almost incredible accounts of their wealth, and still doubt the fact of their having made gold artificially, yet we are compelled to accord to them a high state of civilization, and the possession of as much knowledge in metallurgy specially considered as we ourselves own. We must also admit that in this branch of acquired learning they were in some respects our superiors, particularly in the treatment of copper. With all the evidences of their knowledge in this branch of science we may not consistently laugh down the effort made by them to produce gold from other metals, for this problem was suggested to an intelligence in connection with metallurgical operations fully equal to if not superior to our own.

So far as any large accumulation of gold is concerned, we can reasonably infer that its aggregation did not call for any great display of knowledge, for gold is always found in a metallic state, and its melting and working can be performed by the simplest of metallurgical operations. All we have to do to account for such a condition of accumulation is to suppose that some great source of supply existed of which all traces have now disappeared. We know that there were two avenues open for the collection of gold, the Ural Mountains and the sands of Africa. But they were also rich in silver, and to such an extent that they made their household furniture of it, also using it in connection with gold, to form the caps of columns that adorned their homes. Silver, unlike gold, is seldom found in a metallic state, and it is in fact separated from the ore only by a complicated effort of metallurgical chemistry, and one that requires much more than ordinary melting skill.

It was amongst a people thus skilled in the working of metals that something had been found to suggest the idea that gold could be produced by transmutation, and to learn if we can what there is in nature likely to prompt such a problem is the object of the present paper. Gold is ordinarily found in river gravels and sands, as well as at the bottoms of gulches, whence the greater bulk of the gold produced has been obtained. It is usually separated from the lighter sands and gravels by washing, to accomplish which invention has produced about the same appliances the world over.

Placer gold, as alluvial gold is called, is well understood to be not an original condition of the metal, but a secondary one, and one which has found a new place of repose some distance from

the matrix that formerly held it. All alluvial gold has been liberated from the mountain veins by the crumbling and disintegration of the tops of the elevations, and where erosion has taken place, the gold, which is indestructible in nature, has been set free from the original environment in the vein which held it, and by reason of its greater gravity has descended beneath and through the soil upon the mountain-side, along the inclining face of the rocky slope, until it has reached the lower level of the river or gulch bottom. No salts of gold being found in nature, the surface of the metal is always bright and clean, and, being so soft, ductile, and heavy, its particles adhere by contact to form nuggets. Sometimes an interposing shelf or ledge upon the hill-side will arrest and detain the descending particles until aggregations of a larger size are formed. Such places are called pockets. The breaking away of such a shelf, and the subsequent descent of the gold thus aggregated, by means of gravity, to the lower level of the river bed, accounts for the occasional appearance of the large masses of gold found in river bottoms. The particles of metal occurring in the lower portion of the slope will uniformly be coarser than those obtained higher up, from the effects of aggregation in their passage; and they also begin to show the worn appearance of alluvial gold, from having been carried along over the rough surface of the rocky hill-side in their descent towards the river bed.

Supposing some ancient seeker after the precious metal to have exhausted the supply of a locality by washing the gravels and sands of a river bottom, in following up the hill-side the traces of the descending gold, he would in removing the soil eventually reach a place where all signs of gold would have disappeared. At this point, as he exposed the surface of the mountain-side, he would find a vein of quartz; and this at the top would be much decomposed, having a honey-combed or cellular appearance. Adhering to the quartz, and in some of its cells, he would find particles of gold, and as he made an opening into the vein he would expose to view what we term sulphides of iron and copper, as well as cells containing oxides of these metals, and also gold. When he came to deepen the opening upon the vein, all signs of gold would disappear, and he would find nothing but the quartz and accompanying sulphides. He would hardly suppose the latter to be gold, but, as he found the two to be neighbors, he might infer that the one contained the other, and to settle the question he would call into requisition the services of

his melting friend, fire. When the sulphides were heated, they would give off the fumes of sulphur, and would form oxides of iron and copper, which, though he might not recognize them by these names, he would identify as the same substances that he found in the cells of the quartz with the gold. When he came to wash the product that the fire had made from the sulphides, and found there was no gold, he would be much surprised. But his faculties of perception are very keen; he has them to depend upon, and no books or so-called schools of mines to go to for information, and he has learned to study nature by looking at her square in the face. Now we will suppose him, under such conditions of mental capacity, to be examining a piece of quartz in which there are two features of particular interest in this connection, and these features found to consist of two well-defined cubiform cells which have been opened by the fracture of the piece, and which before its rupture were hermetically sealed, and inclosed within the quartz matrix. These cells both appear to have been shaped by the same agency, the crystalline form of the sulphides. One of the cells is filled with the sulphides, the other contains oxides of iron and copper, which he recognizes as the substances produced from this material by the fire; and with them, within the cell, as it appears, is a small aggregation of gold. He properly assumes that the square form of the cells has been given to them by the crystalline form of the sulphides, and that the latter was the first occupant, and made the cell. How did the sulphide get out, so that the gold could move in, when all the approaches to the cell were sealed up by the surrounding quartz matrix? He reasons that since it could not get out, or the gold move in, the former substance and occupant has been changed, and produced the new-comer, gold.

When these phenomena as presented to ancient alchemy are also before us, we, who claim to be much wiser than the old alchemists, have a way of settling the matter; and we proceed to analyze the sulphides, and from them we do get a trace of gold, though not one ten thousandth proportion of the amount existing in the other cell. We have learned that to investigate any chemical fact, we must take nothing for granted if we seek the truth; and right here, when we fancy we have unraveled the whole mystery, we are met with the troublesome query whether the trace of gold that we have found may not be due to a metamorphosis commenced in the one, and completed in the other; for the amount we have found in the one is but a trifle, compared

with that existing in the other. Growing earnest in our perplexity, we again select with care such portions of the sulphides as we may believe to be in a condition of repose, and make several trials more. Some of the selections do contain a trace of gold, and others do not; but whenever we analyze a piece that shows any evidences of oxidation, and ascertain that the quantity of gold found increases in proportion to the progress of the oxidation very rapidly, we come to the conclusion that we are little better off than the ancient alchemist after all, and we have learned to respect his deduction though we hesitate to accept his facts. We are a little too conservative and careful to jump at his conclusion, but we really feel that we do not require much more persuading to adopt his theory, and we are almost ready to believe that gold may exist in nature as the result of the metamorphosis we have been examining and discussing.

Alchemy found out one leading element which it associated with the assumed production, and that is sulphur; so for centuries this substance has been coaxed, wheedled, and implored to do for alchemy what it seemed to do in nature. But all of man's efforts to harness it into the work are futile, and finally the work has been abandoned, but not until the glittering incentive had led alchemy to perform all the drudgery of elementary chemistry.

Various specimens of ore, exhibited by the speaker, from all the different gold-producing areas of this country, exhibit in diferent degrees the suggestive phenomena described. Interestingly connected with the elucidation of the proposed hypothesis, are two specimens from the same mine in North Carolina, one of them showing the cell formed in a dense mass of the sulphides, and the other a commencement of the assumed evolution. Both of the specimens are fragments of massive sulphides of iron and copper, and within the cell opened by the fracture of the piece is a nugget of gold, surrounded within the cell by the oxides. Upon the other piece, and where the assumed evolution has commenced, the vitreous and glassy surface of the sulphides has been changed, and a thin film of gold coated the crystals. On some of the faces of them, and on such surfaces of the crystals as sloped downwards, the gold has begun the process of aggregation, is thicker at the bottom of the slope than at the top, and when examined with a microscope distinctly exhibits the fact that the film has thickened upon the lower edge of the inclined surface, under the influence of gravity. The average value of these sul-

phides in the gold, as determined by over thirty carefully made assays, was about ten dollars per ton, the selections for assay being made from such material as seemed nearest to a state of repose.

Wherever decomposition had occurred in the deposit, the yield of gold increased at a large ratio. One bushel of the decomposed sulphides, consisting of oxides and gangue, produced, as the writer was informed, over eighteen hundred dollars; this was said to have been found in a small cavity formed in the vein from the decomposition of the sulphides. An examination of the specimen containing the gold shows that the decomposition of the sulphides to form the cell has been in proportion to about nine times the bulk of the gold and oxide occupying the cell.

Careful examination was made of some twenty tons of this ore, to see if any free gold existed in the sulphides, apart from the evidence of decomposition. This ore was all broken up, and a close inspection failed to find any such appearance within it.

All the quartz veins containing gold in the absence of the sulphides, and as occurring in some parts of California and Montana, are of a more recent formation than the others, and if the gold so existing be examined with care, it will be found to contain unmistakable evidences of being water-worn, as if it had been liberated from an older matrix, and had been washed into the crevice with the silicious solution which filled it. Another fact favoring this deduction is that where such veins dip, the gold is nearly all found at the foot wall, and the quartz upon the upper inclined side of the vein is barren.

Amongst other specimens shown to sustain the hypothesis is a piece of baryta or heavy spar. This contains a large nodule of oxide of iron, with a trace of its former existence as a sulphide present in it. The oxide is full of gold, yet there is none in the baryta apart from this connection with the oxide of iron.

A very interesting form of gold is taken from a vein of tough ferruginous aluminous clay existing in various parts of the Southern States. The gold in this deposit is very singularly aggregated, and the metal is not at all worn by attrition, like alluvial gold, but appears in the form of threads, nodules, and cubes, some of the threads being very delicately joined, as if made where it was found and never disassociated from the old connection of the sulphides in the way of the oxidized skeletons of a former crystallization. Masses weighing five pounds have been found in this deposit. Dr. James Crump, of Montgomery County, North

Carolina, had in his possession many curious forms of gold taken from this clay; one particularly so in the fact that it represented a beetle, and this similarity was not one that taxed the imagination at all to see the resemblance. It looked just as though the insect had been entombed in the clay, and the fine particles of gold had insinuated themselves into the cavity, to there aggregate and take the shape of the insect that it displaced, the lines of the sheath upon the back being as plainly delineated as they are upon a real insect. He had also gold in the form of leaves upon the laminæ of slate, where the gold had drifted in between the foliations and taken the place of the cellulose. All the gold found in this clay was of a peculiarly fine quality.

To such as believe in evolution, the hypothesis seems possible, although we know in the laboratory that gold seems the most positively elementary substance of the metallic series. But many are led to believe that matter in the various forms of environment which we dignify with the name of elements has all been evolved from some simple form of substance that once composed the primeval cosmos. It seems to assume no more annihilation of elementary stability to assert that gold is of a derivative origin than it does to believe, as some now do, that bog iron ore (with iron a so-called element) is evolved from the life of the *Gallonella ferruginea.*

RECENT LITERATURE.

GURNEY'S RAMBLES OF A NATURALIST.[1] — Although not specially interested in ornithology, we have been led on from chapter to chapter until all except the special notes, which take up a considerable portion of the book, have been conned over, and we have been led to regard the work as a very pleasant record, by an observing and evidently experienced ornithologist, of travels in some of the most interesting regions of the Old World. Mr. Gurney discovered but one bird absolutely new to Egypt, the lesser white-fronted goose, and this not a "new species." We much relish a foot-note on page 110, in which it is said that "quite seven tenths of the names which have been bestowed on 'new birds' within the last few years have already sunk into synonyms, and the advance of science has thereby been impeded." This evinces sound ornithology in the author! One chapter is mostly devoted to the sacred ibis. An extract will give some idea of the author's style. "Alas! alas!

[1] *Rambles of a Naturalist in Egypt and other Countries.* With an Analysis of the Claims of certain Foreign Birds to be considered British, and other Ornithological Notes. By J. H. GURNEY, JR., F. Z. S. London: Jarrold and Sons. 12mo, pp. 307. For sale by S. E. Cassino, Naturalists' Agency, Salem, Mass.

the sacred ibis is no longer found in Egypt. What would the shaven priests say if they could live over again? My humble opinion is that they would say that in their wild state they never were anything but rarities, and confirm the theory of Dr. Adams[1] that they were imported from the south. I look upon them as an imported exotic, for I cannot conjecture what natural cause can have operated upon them to produce their extinction, if they ever were natives. They were domesticated, in time they became totally dependent on man, Egypt was conquered by another nation, the hand of protection was withdrawn, and the breed died out." Savigny while in Egypt saw one sacred ibis alive. "Its extinction, therefore, must be of comparatively recent date. Fortunately it has not been extirpated altogether, like the great auk and the *Nestor productus*. It is still common in more southern regions, though driven from its stronghold in Egypt." Concerning animal life in Egypt the author thus pleasantly discourses, and with this extract our notice closes: "While my attendant is rolling a cigarette, I pause a moment to wonder what goal all the thousands of pale Egyptian swifts which are careering by can have. They pass by, but there is no check; others take their place. Can they who press on with such steady purpose stop short of Europe? Their heads are all to the north; they are flying low, like birds with a settled object. Less numerous, but still innumerable, and with the same aim, and flying in the same direction, I see a cloud of sand martins. At the rate they are now going they will soon be decimating insect life at Cairo, and banking over the pools of El Tostat, in conjunction with the rufous-breasted swallow and its distinct English congener. But all Egyptian birds are not migrants. There are the stay-at-homes, and one of these is the hooded crow, which sits in the sycamore-fig, announcing with loud caws, to all who may be interested in the fact, that she has laid her eggs; and another is the parasitic greater spotted cuckoo, which chuckles at the thought of having added one to the number. These belong to a class which is divisible into flats and sharpers — birds who 'do' others or are themselves 'done.'

"In the long grass the fantail builds her gem of a nest, and the *Drymæca gracilis*, another minute warbler, chirrups to her young ones, 'branchers' already with little bodies and no tails.

"Small rodents spring into the ditches, lizards scuttle up the walls of houses, the moving snake eyes the fledgeling, and the sly fox trots away among the tobacco plants. So great is the overflow of animal life that no one can fail to be struck by it. Only those can appreciate the scene in its zoölogical aspect who are capable of discriminating between the many species, though all can and must listen with unmixed feelings of pleasure to the chanting of the choristers and the hum of many insects, and all must feel the balmy air and fragrant luxuriance of foliage and blossom, and derive enjoyment from the view before them,

[1] Ibis, 1864, page 32.

the rock-cut tombs, the tents, the camels, the Bedouins with their long guns, the lateen sails upon the river, and the mountains in the hazy distance.

"I shall be pardoned if I next submit a brief companion picture of the prominent species to be met with in June at such a lake as the Faioum (Birket-el-Korn). First, the little long-tailed African cormorant goes by with straight, undeviating flight, like one who knows what place he wants to go to and is going there, leaving behind him the wanton terns, who have no object in life but lightly to sport over the water as they watch for their finny prey, assured that the warm sun will take care to incubate their eggs. In noisy conclave the buff-backed herons trim their nests, and the shyer squacco is uneasy at any disturbance the meaning of which he does not understand, while the cautious egret takes his stick away again, wisely jealous of revealing the whereabouts of his yet unfinished edifice. The Dalmatian pelican swims away with all sail set, or flaps and glides and flaps and glides over the water, his huge form mirrored on the surface, startling the basking fish, which hurry from the presence of their enemy. Marbled ducks in pairs rise from among the sedges; agile grebes put their trust in diving; the tall reeds quiver as the green-backed porphyrio seeks their friendly shelter; the reed warbler sounds a loud alarum. All fly to the nearest cover and in those thick beds they find a secure haven."

BOUCARD'S CATALOGUE OF BIRDS.[1] — This useful list gives the names and localities of all known living birds, numbering 11,030 species in 2456 genera, though in the author's opinion "many of these genera and species must be eventually abolished." The subgenera are placed as genera, and M. Boucard believes that it does harm to ornithological science "to multiply the genera and the subgenera, as it has been the practice to do lately." The classification followed is a new one, beginning with the *Struthiones*, the lowest living forms, and ending with the humming-birds, which the author regards as the most recent and probably the most perfectly organized birds. Four new "orders" are proposed, namely, *Palamedeæ* for *Palamedea*, *Chauna*, and *Ischyornis*; *Pterocles* for the *Pteroclidæ*; *Phœnicopteri* for *Phœnicopterus*; and *Trochili* for the humming-birds. As a check-list for exchanges and arranging museums we doubt not the book will be found to be very convenient.

THE WILD FLOWERS OF AMERICA.[2] — It is a singular fact that many of our more common and beautiful wild flowers have never been figured, and we are glad that in the present series an attempt is to be made

[1] *Catalogus Avium hucusque Descriptorum.* Auctor ADOLPHUS BOUCARD. Londini. 1876. For sale at 35 Great Russell Street, London, W. C.; and by S. C. Cassino, Salem, Mass.

[2] *The Wild Flowers of America.* Illustrations by ISAAC SPRAGUE. Text by GEORGE L. GOODALE, M. D., Assistant Professor of Vegetable Physiology, and Instructor in Botany in Harvard University. Part I. Boston: H. O. Houghton & Co.; New York: Hurd and Houghton.

to supply the deficiency. The present fasciculus, which forms the first part of a work of which it is intended that two parts shall be issued annually, contains colored plates of *Aquilegia Canadensis* L., *Geranium maculatum* L., *Aster undulatus* L., *Gerardia flava* L., and *Gerardia tenuifolia* Vahl. The artist, Mr. Isaac Sprague, is well known by his excellent outline drawings in Gray's Genera and in the botanical reports of several of the western surveys. The present plates are accurate in drawing and brilliant in color, that of the columbine being especially striking. The two species of Gerardia are figured on the same plate, but, although this is perhaps an advantage in a botanical point of view, it must be confessed that the general effect is not pleasing.

Accompanying the plates are twelve pages of text by Prof. G. L. Goodale. The task of describing plants which have a popular interest, as in the case of the species figured in the present fasciculus, is by no means easy or gracious. The writer is too apt to confine himself to vague sentimentalities. This danger Professor Goodale has successfully avoided, and instead of copious extracts from Mrs. Hemans and Wordsworth he has, very much more to the purpose, given quotations from Hermann Müller and Sprengel, writers who, although by no means unfamiliar to those who have taken a botanical course at Cambridge, are probably new to the majority of those who purchase the present work. If Mr. Sprague has made the Wild Flowers of America a work which will be sought by all lovers of the beautiful, Professor Goodale has done no less for those who seek instruction, pleasingly conveyed, with regard to our common native plants. The price, $5.00 a part, seems rather high, but if, as we learn from the publisher's announcement, the first edition is already nearly exhausted, it cannot be said to be too high.

RECENT BOOKS AND PAMPHLETS. — Synopsis of American Wasps. By Dr. H. de Saussure. Solitary Wasps. (Smithsonian Miscellaneous Collections. 254.) Washington, D. C. 1875. 8vo, pp. 385.

Studien zur Descendenz-theorie. II. Ueber die letzten Ursachen der Transmutationen. Von Prof. August Weismann. Leipzig. 1876. 8vo, pp. 336. 5 plates.

Seventh Annual Report of the Geological Survey of Indiana, made during the Year 1875. By E. T. Cox, State Geologist, assisted by Prof. John Collett, Prof. W. W. Borden, and Dr. G. M. Levete. Indianapolis. 1876. 8vo, pp. 601.

Entomologische Nachrichten. Herausgegeben von Dr. S. Katter. Jahrgang I. 1875. II. Heft i., ii. 1876. C. F. Vieweg in Quedlinburg. 8vo.

Recherches sur les Dicyemides, Survivants actuels d'un Embranchement des Mésozoaires. Par Édouard Van Beneden. Bruxelles. 1876. 8vo, pp. 111. 3 plates.

Our Present Knowledge of the Nidification of the American Kinglets. By Ernest Ingersoll. (From the Bulletin of the Nuttall Ornithological Club. Vol. i., No. 4. November, 1876.) 8vo, pp. 80.

Descriptions of some Vertebrate Remains from the Fort Union Beds of Montana. By E. D. Cope. (Extracted from the Proceedings of the Academy of Natural Sciences of Philadelphia, October 31, 1876.)

Increase Allen Lapham. A Memorial. Read before the Wisconsin Natural History Society. By Charles Mann. 8vo, pp. 21.

The Land-Birds and Game-Birds of New England. With Descriptions of the

Birds, their Nests and Eggs, their Habits and Notes. With Illustrations. By H. D. Minot. Salem, Mass.: Naturalists' Agency. Boston: Estes and Lauriat. 1877. 8vo, pp. 456.

GENERAL NOTES.

BOTANY.[1]

HOMOGONE AND HETEROGONE (or Homogonous and Heterogonous) FLOWERS. — That difference in relative length or height of stamens and style, reciprocally, which in Torrey and Gray's Flora of North America was very long ago designated by the term *diœco-dimorphism*, Mr. Darwin, who detected and has made much of the meaning of the arrangement, called simply *dimorphism*. Besides these *dimorphic*, he also brought to view *trimorphic* flowers. The first name is too long for use and carries with it some ambiguity, since it may imply a separation as well as a diversification of the sexes. Mr. Darwin's term has the disadvantage of not indicating what parts of the blossom are *dimorphic* (hermaphrodite flowers may be dimorphous in the perigonium), and a more generic name is now required on account of trimorphic, etc. This has been supplied by Hildebrand in Germany, who has introduced the term *heterostyled* and the counterpart *homostyled*. These are not particularly happy appellations; for the difference is in the stamens as well as in the pistil, and in the latter is not always restricted to the style. Well-established terms ought not to be superseded on the ground of improvement; but those which have not yet taken root sometimes may be. Following the analogy of *perigonium* or *perigone*, I propose the more exactly expressive term of *heterogone* (or *heterogonous*), for these flowers such as those of *Primula*, *Houstonia*, *Lythrum*, etc. The counterpart *homogone* (or *homogonous*) would designate the absence of this kind of differentiation. These terms, either in Latin or English form, would work well in generic or specific characters, and have the advantage of etymological correctness. —ASA GRAY.

A MADROÑA SWALLOWS AN OAK! — "Being yesterday in the country in this neighborhood, I saw what seemed to me a curious botanical phenomenon, which may be of interest. The phenomenon is this. I found in San Rafael, growing side by side, almost from the same root, a Californian oak and a madroña, but on examining the madroña, I found that inside of it was the dead body of the oak that ought naturally to have proceeded from those roots, and the madroña was gradually overgrowing trunk and branches, laying its outside wrapper along like deposits of fat. The trunk was overgrown all but about a foot in some places, less in others (the trunk being perhaps seven or eight feet in circumference), and the branches were gradually, apparently, covered by the madroña covering, the solid part being madroña, and the dead limb of the oak projecting. Again, close by was another pair, oak and madroña,

[1] Conducted by PROF. G. L. GOODALE.

growing in the same way, both very large trees; but in this case the madroña trunk was perfect, the branches very flourishing, and only here and there the remnants of the oak branches projecting, which were being rapidly covered, and apparently in a few years there will be no external evidence that there was anything but a madroña, yet it has plainly absorbed a large oak tree. Farther on, investigating other madroñas, I found exactly the same thing, except that the tree absorbed was a bay (*Oreodaphne*)." — PELHAM W. AMES.

THE SEXUAL REPRODUCTION OF FUNGI. — That several classes of fungi exhibit a sexual as well as a non-sexual mode of reproduction has been considered to be established by the researches of De Bary and others. In the section of Ascomycetes this was held to be effected by the union of the pollinodium or antheridium, as male organ, with the ascogonium, resulting in the production of the asci. The most recent investigations of Van Tieghem and Cornu throw the gravest doubts on this supposed sexual process. They assert that the so-called "pollinodia" of De Bary are in reality strings of conidia or vegetative cells which themselves germinate without any process of impregnation. Van Tieghem's observations were chiefly made on the two Ascomycetous genera *Chætonium* and *Sordaria*, but apply also to lichens and to the alleged conjugation of male and female organs which is stated by some writers to take place on the mycelial threads of certain Basidiomycetous genera, as *Coprinus*. The life-history and mode of reproduction of all the Fungi seem to be still involved in the greatest obscurity; and all the new systems of classification based on these characters must be regarded as provisional only. — A. W. BENNETT.

BOTANICAL CLUB AT PROVIDENCE, R. I. — It gives us pleasure to announce that a Botanical Section of the Franklin Society has been recently formed at Providence, and that it has already gone to work with a will. Short reports of the meetings have been published in the Providence papers, and they indicate a purpose on the part of the society to thoroughly explore the remarkable flora of Rhode Island.

BOTANICAL PAPERS IN RECENT PERIODICALS. — *Flora*, No. 28. Dr. Müller, New Brazilian Rubiaceæ. Carl Kraus, Mechanics of the Growth of Seedling Roots. De Krempelhuber, Brazilian Lichens. No. 30. J. Wiesner, A New Self-Registering Auxanometer (an instrument for measuring rate of growth). No. 31. Westermaier, Cell-Division in the Embryo of Capsella Bursa-Pastoris. Drude, On a Mixed Heath-and-Meadow Vegetation.

Botanische Zeitung, No. 41. Eriksson, On the Point of Growth (punctum vegetationis) in the Roots of Dicotyledons. No. 42. Behrendsen, On the Flora of the Northeast part of Zemplin (Hungary).

No other foreign journals have at the present date come to hand.

ZOÖLOGY.

Notes on some Oregon Birds. — *Ampelis garrulus* (Linnæus). This bird was first noticed here as early as November, but at no time was it found in large flocks. The greatest number I saw at any one time did not exceed twenty. They feed on the wild rose berry almost if not exclusively during the winter, filling their crops to their utmost capacity and growing very fat. At times they were very shy, at others just the reverse. I noticed them only along the creeks, where they were feeding or resting. I believe they roost among and on the wild rose bushes, as I have found them there at twilight and early morning. I have not noticed them making any unusual noise, though in large flocks they might make plenty of i., and very likely would. According to Degland, the female has no white or yellow on the inner webs of the secondaries. I find that each has the white or yellow extending around the point and on the inner web of the secondaries.

Pipilo megalonyx (Baird). This bird appeared here in early spring; was quite shy. Its resort is along the creek, rarely leaving it, though at times it is seen on the neighboring foot-hills. I have seen it fly several hundred yards without lighting. It feeds on the ground, scratches a great deal, and is restless. At times they fly rather high. They leave here in April, returning on their way south in September, about the 15th.

Passerella Townsendii var. *schistacea.* This bird also is very shy, seeks the dense thicket and undergrowth, and scratches on the ground among the dead leaves, doubtless feeding on seeds and insects. I believe it breeds here, but am not positive. Goes south in September.

Junco Oregonus Townsend. Winters here; migrates late in the spring, but, I think, only to the high mountains. Its habits are much the same as other snow birds.

Melospiza melodia var. Found here early in the spring. It is a great songster and sings very sweetly. I do not know the variety.

Melanerpes torquatus (Wilson). Breeds here and is numerous. I know very little about them.

Pelecanus trachyrhynchus (Latham). Breeds here, makes its nest on a lonely island, in the sand or loose earth, lines it with a very little grass or roots. Its eggs are white and rough, as a rule two only in a nest, though some are found with three eggs. They nest in large groups, the nests being side by side and covering acres. — George R. Bacon, U. S. A., Camp Harney, Oregon.

Habits of the Whistler. — March 7, 1874, Sidney B. Ceby, of Rowley, shot in Castle Neck River, Ipswich, Mass., a female whistler or golden eye (*Bucephala Americana*) whose stomach contained nothing but Indian corn, *Zea mays*, of the variety grown in the Northern States. The kernels were whole, as if recently swallowed.

Castle Neck River is a purely tidal estuary, the water is salt, and the place where this bird was shot was only half a mile from the open sea. At this time of the year no corn could be obtained in the fields, as the farmers all house their corn in this locality, in the fall, and it is a mystery where the bird could have obtained it, as it is the wildest of the ducks that visit this part of the coast.

I have never found in the stomachs of this species anything but fish, shell fish, and marine plants and insects, except in this instance, which I I think is the only one on record. The bird was given to me by Mr. Ceby, and upon dissecting it I found the corn as above stated. If any one can give a like instance among the *sea ducks* I should like to hear of it through the columns of the Naturalist. — J. FRANCIS LEBARON.

ANTHROPOLOGY.

CORDATE ORNAMENT. — A stone object, plowed up in Chester County, Pennsylvania, some twenty years ago, has just been brought to my attention. It is " heart-shaped," made of a coarse, micaceous sandstone, and measures two and a quarter inches from the notch to the apex, two and a half inches across the broadest portion of the lobes, and averages three fourths of an inch in thickness, one lobe being somewhat larger than the other. The edges have evidently been worked and rounded by aboriginal tools, and the notch may have been partially cut at the same time, as the upper portions of the lobes would indicate. This has, however, been deepened artificially by the over-zealous discoverer, with a metal instrument, as may be seen in the sharply cut outlines, which possess a much more recent appearance than the other portions, the grains of sand, in many cases, having been severed and smoothed, The object was, possibly, intended for a rude ornament; or it may have been fashioned for purposes of sepulture. The former supposition seems improbable, as the material is so coarse and crumbles easily, while there is no orifice or projection by which it might have been suspended. The point is somewhat truncated, which has probably been effected by pounding, as it has a ragged, rough appearance.

The two-lobed form is but a conventional device of civilized man to represent the human heart, and it is not at all probable that the North American Indian employed such a figure before he came into contact with the Europeans, especially as he does not use it in his paintings and etchings at the present time, but copies directly from nature. To be sure, the symbol was used in the hieroglyphics or picture-writings of ancient man in the eastern hemisphere, but we have no proof that it occurred in the rude rock-etchings of nomadic tribes in the United States. This form of ornament is so scarce that it can hardly represent a type. I have seen but this one and have heard of but two others, one of which is figured by Dr. Rau in his Archæological Collections of the United States National Museum. The latter was said to have been

found in an Ohio mound, lying on the neck of a skeleton. The three, occurring in widely separated localities and made by different races, must be considered as accidental specimens. No one of them, however, can be certainly considered as a purely aboriginal production, all having been either tampered with or manufactured for purposes of fraud. — E. A. Barber.

Anthropological News. — Number 23 of the publications of the Western Reserve and Northern Ohio Historical Society is a tract of eight pages upon Archæological Frauds, written by Colonel Charles Whittlesey. A list is given "of all the engraved stones in the United States," nine in number, which have come under the observation of the author. They are the Grave Creek Stone; a quartz axe, sketched by Dr. G. J. Farish for Professor Wilson; a grooved axe or maul, reproduced by Dr. Wilson, on page 412 in his Prehistoric Man; the Holy Stone, of David Wyrick; an epitome of the ten commandments in Hebrew, found by Mr. Wyrick; a stone similar to the Holy Stone, from a mound in Licking County, Ohio; a grooved stone axe, from Butler County, Ohio; a stone alleged to have been plowed up on the eastern shore of Grand Traverse Bay, Mich.; and a stone maul found, in 1875, in an ancient mine pit, near Lake Desor, Lake Superior. The prinicpal part of the tract is devoted to the various copies and versions of the famous Grave Creek Stone. Six drawings are given, the last being a copy used by Monsieur Levy Bing, at the Congress of Americanists, at Nancy, in good faith, as a Canaanitish inscription. Colonel Whittlesey joins with our ablest archæologists in deprecating the credulity which attaches to these palpable frauds.

The Pennsylvania Historical Society have published Heckewelder's Indian Nations, as the twelfth volume of their series. The apology that Mr. Heckewelder had filled his book with "the national traditions and myths of the Indians" can but provoke a smile from those who have sought for days through wearisome pages to hear the story of the red man's faith from his own lips. This reprint of an old book has our unqualified praise for the spirit which conceived it, and the taste and accuracy which characterize its execution.

The Smithsonian Report for 1875 is just issued and contains the following anthropological matter: International Code of Symbols for Charts of Prehistoric Archæology (illustrated), by O. T. Mason; Certain Characteristics pertaining to Ancient Man in Michigan, by Henry Gillman (illustrated); The Stone Age in New Jersey, by C. C. Abbott, M. D. (223 illustrations).

The war in the Turkish provinces has awakened a fresh interest in the ethnological questions involved in this classic land. Perhaps there is no corner of the world where the questions of race, religion, language, and government more overlap and intermingle. To those of our readers who take an interest in these phases of the controversy we recommend the

two articles in the *Geographical Magazine* for October, by Mr. Ravenstein, accompanied by four maps exhibiting the spread of Mohammedanism, the political divisions, the comparative density of population, and the nationalities; and the History of the Mongols from the Ninth to the Nineteenth Century, by Henry H. Howorth. — O. T. MASON.

GEOLOGY AND PALÆONTOLOGY.

THE GEOLOGICAL SURVEY IN CHARGE OF PROF. F. V. HAYDEN. — The productiveness of the work pursued in America by Professor Hayden, the greatness of the results obtained by this savant and the collaborators whom he has associated with him, the hope and expectation of having science enriched by new discoveries of which those of these last times seem but a prelude, — all these considerations have deeply impressed the French savants, who attentively watch the researches of every kind in geography, physics, botany, zoölogy, and especially geology and palæontology, pursued through the unexplored Territories of the United States west of the Mississippi, and towards the Rocky Mountains. It would be impossible to trace out, even in a summary, what is the most striking and interesting part in the undertaking of Professor Hayden, and I must merely mention some essential points which from the speciality of my studies I am prepared to appreciate to their full value. It is certain, first, that the Yellowstone or Geyser region, recently surveyed and preserved by the wisdom of the Federal government against the danger of devastation, put to the disposition of science the exposition of an assemblage of phenomena of the highest interest. Their examination will serve to explain the mode of formation of the lacustrine deposits of Europe, where the geyserian action is so remarkably visible. Henceforth it will be easy to follow the proceedings formerly employed by nature on the European Continent, and which now are in full action in the central part of the American Union. It is also evident to the geologist who considers the general classification of the formations, as it is fixed from the order of the materials as they exist in Europe, that a great revolution is preparing in geology from the discoveries in regard to the stratigraphy of the Territories recently explored under the direction of Dr. Hayden. The Dakota group and the lignitic formation constitute, in fact, two systems of an enormous power, wherein the fresh-water formations of an uncommon thickness are directly superposed on the marine beds, or in alternation with them. Of these two systems the one is incontestably cretaceous, the other as incontestably tertiary, and both, equally rich in fossils, animal and vegetable, are so intimately bound together that the passage from the one to the other is by [illegible] of degrees without interruption or gap.

Now thi [illegible] 'act of immense importance in this, that it disproves all [illegible] osed to have been observed positively in Europe in [illegible] l and partial phenomena. In the minds of

the most eminent geologists of this side of the Atlantic the gaps which distinctly separate the cretaceous from the lower tertiary were admitted as corresponding to the end of a great period, and marking its separation from the following one, abruptly beginning a new order of things. Thanks to the American discoveries due to Dr. Hayden's perseverance we have now before us a formation composed of a union of strata of surprising extent, and these strata when they become carefully studied will teach us how the transition between the upper cretaceous and the most ancient tertiary has proceeded.

The radical separation, admitted until now, of the secondary times in regard to those which follow, is therefore uncertain in such a way that if geological researches, instead of beginning in Europe, had been first made in America, the classification would have been modified according to the facts recently obtained by Dr. Hayden; and we can even assert that it would have been founded upon at least different if not opposite bases. The natural consequence of the discovery of these new formations has been a rich harvest of animal and vegetable fossil remains, vertebrate and invertebrate. Here I will only speak about the plants which by their profusion and their variety form a complete herbarium, by which Mr. Lesquereux, as learned as modest, will be able to patiently reconstruct the vegetation of an epoch of which, a few years ago, even the existence was still unknown, at least contested. Nothing, indeed, was more obscure than the flora of the second half of the cretaceous until the Dakota group offered us their share of vegetable fossils. This obscurity was, and is still, a great obstacle to the study of those plants which show us the most ancient Dicotyledons, and take us back to an age when the vegetation of our globe was being completed by the addition and the rapid development of the highest and most numerous class which composes it at our time. Before this epoch, reduced as it was to a small number of relatively inferior types, the vegetation could evidently furnish to large land animals insufficient food. It is only from the appearance of the Dicotyledons just at the epoch when the strata of the Dakota group were deposited, that both kingdoms began their completion by the rapid and successive development of what they have most perfect in land animals and plants, before the arrival of man himself, this last complement of creation.

Not only have the plants of the Dakota group presented to us types of which we could not formerly suppose the antiquity, but in the tertiary system which immediately follows the Dakota group, in the lignitic formation, the researches inaugurated by Dr. Hayden have already exposed to our knowledge the remains of a number of floras of various stations and of great richness. This vegetation, distinct from that of the Dakota group, is far more recent, but it has also its proper interest. Its relation with European contemporaneous floras has to be determined; its most interesting study will demand a great deal of patience and

hard work. It must be completed in time, by a long series of new researches, and nobody is better able to continue them on the same plan than Dr. Hayden, who has directed them until now with such thoughtful zeal and clearness of plan. The magnitude of the results already obtained warrants the hope of future discoveries. — COUNT G. DE SAPORTA, of Aix, France.

THE GEOLOGY OF ITHACA, NEW YORK, AND THE VICINITY. — The Cayuga Lake basin of Western New York extends in a general north and south direction, attaining a length of over forty miles. The land inclosing it on the north is comparatively low, and the lake is broad and shallow. Southward the land increases in elevation, the lake becomes deeper, and the head of the basin is inclosed by a high hilly region. Along the shores of the lake for its entire extent the various rocky strata from the Salina group to the Chemung are admirably exposed. Ithaca occupies the low alluvial plain at the head of the lake, about four hundred feet below the general level of the surrounding country. Many of the streams entering the valley at this point flow through deep gorges rendering the underlying Chemung rock easily accessible. From Fall Creek, which flows into the lake basin just north of the village, southward to the Pennsylvania line there is a continuous stretch of Chemung strata. Excepting for building-stone and flags, the economic value of this group is not great, as it is made up of shales and thin beds of sandstone. The characteristic fossils found at Ithaca are *Spirifera mesacostalis*, *S. mesastrialis*, and *Orthis impressa*. In addition to these there are a number of species of lamellibranchs, gasteropods, cephalopods, — some of which are quite large, — and brachiopods other than those mentioned. The best, and in fact the only, exposure of the Portage group, which underlies the Chemung, is immediately below the Ithaca Fall in the Fall Creek Gorge. This has afforded well-preserved fossils, some of which are quite rare. *Spirifera lævis*, characteristic of the strata, occurs in great numbers, and so well preserved that the spires are frequently visible where the shell has been removed. But the exposures along the lake shore offer a richer field to the collector. By reference to a geological map of New York the various rocks of the Silurian and Devonian ages will be seen to stretch in long bands from east to west, that is, the beds all dip to the south and are imposed one upon the other in their regular order. As the Cayuga Lake basin cuts them transversely, it forms the basis of an excellent section of the western part of the State. The Hamilton formations are here well developed and are exposed along the lake shore for a distance of twenty-five or thirty miles. North of Ithaca the black, thinly laminated Genesee Shale is met, and, forming cliffs along the shore and precipitous walls to the small streams entering the lake, it continues exposed for two or three miles, thinning out and overlapping the Hamilton rocks proper. This shale affords very few fossils, though some well-preserved plant remains have been found. Separat-

ing the Genesee Shale from the Hamilton Shales a thick band of limestone — the Tully Limestone — rises from the water and after an undulating course of several miles passes off at the surface. Directly beneath this is the Moscow Shale, a dark, laminated mud-rock easily disintegrated by water, the Encrinal Limestone, — a very thin bed, — and the Ludlowville Shale. The Tully Limestone forms a rocky table upon which the streams often flow for a considerable distance, the dip of the bed frequently being so slight as to present nearly a level surface. As they approach the lake the water flows over the hard rocky table and cuts its way through the softer deposits. These are easily disintegrated by the combined action of frost and water, and are washed away, forming caverns below the limestone, which after a time breaks off, leaving large masses in the bed of the stream. This is particularly well exemplified in the glens about Ludlowville (eight miles north of Ithaca) and at Shurgur's Glen, near the lake shore. Both of these localities are much frequented by collectors. *Spirifera granulifera*, *S. medialis*, *S. mucronata*, and *Athyris spiriferoides* are found there in great abundance, also *Phacops bufo* and other trilobites, many species of lamellibranchs, and a number of cephalopods. This formation, known to geologists as the Hamilton Group, including the Tully Limestone, the Moscow Shale, the Encrinal Limestone, and the Ludlowville Shale, continues for many miles along the lake shore. From an economic stand-point the Tully Limestone only is important, being valuable for lime and building purposes. The only minerals found are calcite, in small quantities, and iron pyrites.

We turn now to the superficial deposits and water-courses. At Ithaca there are two distinct types of river or creek valleys — the one with rounded and well-worn sides, the other bordered by precipitous walls of rock. To the latter class belong Cascadilla and Fall creeks, which flow into the Ithaca plain from the east. Their valleys are true valleys of erosion, having been formed since the withdrawal of the vast ice-sheet which swept over this portion of North America in quaternary time. With the exception of Six Mile Creek Valley and that of Cayuga Inlet, which open into the lake basin from the southeast and south respectively, all the streams of this immediate vicinity flow through deep cuts or cañons, in which they descend by numerous cascades and water-falls to the lake. As their valleys are mere chasms, they make no appreciable change in the general contour of the land. With valleys of the first type, however, the effect is of an entirely different character. They are distinctly marked. Their longer slope and greater width make a prominent feature in the topography of Ithaca. Noting in addition the depth at which the water flows, and the small number of cascades and waterfalls, the conclusion is at once reached that these valleys have been acted upon by some agency not now in operation. We can observe changes going on in Fall and Cascadilla creeks; we can easily understand how their deep, rocky cañons could be formed and are still being formed by

the action of water and frost upon shale, and we can readily see that the conditions which obtained in the formation of these valleys could never explain the deep, well-marked valleys of Six Mile Creek and the Cayuga Inlet, with their sloping banks and knolls and terraces. These deep, well-worn valleys are undoubtedly the result of glacial action. The mass of ice which filled the Cayuga Lake basin, dividing at its southern extremity, one part — the larger — flowed to the south, wearing down the Inlet valley, and the other traversed the Six Mile Creek valley, both of which were occupied by preglacial streams. The scratches on the polished surface of the underlying rocky table, as seen at the quarry in front of the buildings of the Cornell University, on the eastern edge of the basin, indicate that the glacier followed a direction a little east of south, corresponding with that of the lake. Among the drift accumulations are found bowlders of Oriskany Sandstone, and masses of Hamilton shale, formations which occur to the north, together with small granitic bowlders. The valley of Six Mile Creek furnishes some special examples of the drift phenomena. In several places its old channel has been completely choked up with masses of morainic débris about which the present stream has been obliged to cut its way through deep cañons. It was in this valley, at Mott's Corners, a few miles from Ithaca, that the remains of a mastodon were discovered several years since.[1]

In the cañons of this creek and in the gorges of those streams of more recent origin trap dykes are not uncommon. In some cases they thin out before reaching the surface, as in the cañon of Six Mile Creek above Green Tree Falls. There is no apparent displacement of the strata, the dykes being merely cracks filled with igneous rock.

Intimately related to the geology of Ithaca is the problem concerning the origin of Cayuga Lake. At present this has not been satisfactorily solved. Theories have been advanced, but as yet none are sufficiently matured. A consideration of this subject will require a careful and detailed study of the entire lake system of Western New York. While Ithaca does not present that field of study in structural geology to be found in a mountainous or disturbed region, it does offer many attractions to the collector and student of superficial deposits. — FRED. W. SIMONDS, Cornell University.

GEOGRAPHY AND EXPLORATION.

EXPLORATIONS OF THE POLARIS EXPEDITION TO THE NORTH POLE. — The reports of the scientific results of the Polaris expedition have been delayed simply, we are sorry to say, for want of means for publication. Dr. Bessels, the scientist of the expedition, made valuable collections of animal life at Polaris Bay, between latitudes 81° 20′ and 81° 50′ N., and soon after his return placed in the writer's hands the insects and fresh-water crustacea. Now that the English expedition has returned it

[1] See American Naturalist, v. 314.

is deemed expedient to publish a preliminary notice in order to secure priority. The Hymenoptera were represented by *Bombus Kirbyellus* Curtis, which occurred at Polaris Bay, May 31st and July 10th, and a new species, apparently of an ichneumon fly, *Microgaster Hallii*,[1] found in cocoons at Polaris Bay in June and again July 4th.

Of Lepidoptera *Laria Rossii*, a moth closely allied to our *Dasychira*, was obtained in all stages from the egg to the imago. The eggs are spherical, smooth, and white, 0.06 inch long, and laid in a mass of about sixty, and, as in *Orggia*, upon the cocoon. The larva when half grown is broad and short, the body, including the hairs, measuring 0.60 inch in length and 0.30 in breadth. The body is densely covered with long, fine reddish-brown hairs projecting in all directions and concealing the head and end of the body. There are six large, short, dense, subconical tufts, the two anterior and two posterior ones black, the middle ones yellowish. Head and body black. The full-fed larva is a little longer, the head broad, and large, and black, as is the rest of the body, including all the feet. In this stage the dorsal tufts are all black, with the hindermost one acute, and more prominent than the others; two segments intervene between the fifth and sixth pair. It is 1.60 inch long and 0.60 inch wide.

The cocoon is loose and thin, made of the long hairs of the caterpillar, held together by a thin, fine, silken web. There is an inner layer of hairs held in place by a very slight web. It is gray in color, and is an inch and a half long by one inch in diameter.

The two specimens of the moth are male and female, well-preserved, and agree with Curtis's description, except that the hind wings are unicolorous, with no "broad, blackish margin."

In the same bottle with the caterpillars of *L. Rossii* occurred a *Tachina* puparium of the usual form and 0.36 inch in length.

Besides this species occurred *Anarta Richardsoni* (Curtis) and *Glaucopteryx sabiniaria* (Curtis) with its larva, already described by the writer in the Monograph of Phalænidæ of the United States.

The following *Mallophaga* have been identified by Mr. S. E. Cassino: *Physostomum mystax* Burm., from *Larus eburneus; Docophorus lari* Fabr., from *Larus glaucus; Goniodes colchici* Denny, from *Strepsilus interpres.*

A small, blackish Poduran, *Isotoma Besselsii*,[2] occurred in abundance

[1] *Microgaster Hallii*, n. sp. Medium sized, black, shining a little more than usual. Antennæ brown-black. Fore and middle pair of legs dark brown. Hind legs a little paler, with the basal third of the hind tibiæ and tarsi pale brown. Venation as usual, with the pterostigma narrower than usual instead of being nearly equilaterally triangular, as in some species. Length 0.12. Twelve specimens. Cocoons of the usual cylindrical shape; white. Length 0.17 inch. Two species of this genus have been recorded by Schiödte from Greenland, but not described. Dedicated to the memory of the late Captain Hall in command of the Polaris expedition.

[2] *Isotoma Besselsii*, n. sp. Intermediate in form between *I. tricolor* Pack., and *I. nivalis* Pack. Body long and slender, antennæ but little longer than the head; joints

at Polaris Bay, July 5, 1872. The Arachnida were represented by four species, two of which have been identified by Mr. J. H. Emerton. *Erigone psychrophila* Thorell occurred at Polaris Bay June 3, 1872, and there were two unnamed species from Polaris Bay. At Foulke Fiord *Lycosa glacialis* Thorell was collected. All the spiders have been sent to Dr. Thorell to report upon. Upon the body of a *Bombus Kirbyellus* occurred several specimens of a *Gamasus*.

Of fresh-water crustacea, besides a Copepod, *Daphnia rectispina* Kroyer occurred abundantly at Polaris Bay, August 1, 1872, as well as *Branchinecta groenlandica* Verrill. — A. S. PACKARD, JR.

MICROSCOPY.[1]

ILLUMINATION IN CONNECTION WITH POLARIZATION. — Mr. W. K. Bridgman, in a paper read before the Queckett Club, urges the importance of polarization as an element of microscopical illumination. His thoughtful and suggestive paper is very interesting, though far from conclusive in its demonstrations, and greatly marred by an apparent confusion in respect to the propagation, diffusion, and sensation of light. The essential point of his theory is that "it is the polarity induced by the impact of the ray, which excites or confers upon the reflected or refracted portion of the ray a condition enabling it to convey the impression of the object to the eye, and the desideratum is to restrict the effect as much as possible to this one action." It is not polarized light, but the act of polarization to which he attributes the effect. The excellence, for microscopical illumination, of light from a white cloud opposite the sun he attributes to its entire freedom from polarization, while the inferiority of light from a direction at right angles to this, or from the blue sky, is attributed to its being strongly polarized, a scattered polarization being said to afford the worst possible kind of illumination for the microscope. The author finds the best angle at which the light can be allowed to fall upon a painted surface to be its polarizing angle of about 56°, and to an approximate coincidence between the angle most conveniently obtained and the polarizing angle he ascribes the easy and general success in obtaining a good illumination of opaque objects by means of the side reflector or the condensing lens ; though the result is at least equally well explained, in both cases, on the old theory that this is the angle at which an intense illumination is easily obtained without the view being obscured by a glare of reflected light. In the use of the Lieberkuhn, the author attributes the facility with which delicate details of structure are rendered visible by light from one edge,

rather short and thick. Spring much longer than in *I. nivalis*, but shorter than in *I. tricolor*, not reaching to the insertion of the hind legs, while the fork is as long as the basal joint. It is black, and 0.06 inch in length. It differs from any American or North European species, and is certainly not the *Podura humicola* of Fabricius.

[1] Conducted by DR. R. H. WARD, Troy, N. Y.

though quite obliterated by a reflection from its whole surface, to the availability of light at the polarizing angle as compared with vertical rays; but in fact the instrument does not furnish a vertical illumination in any case, and when all light is stopped off except from its marginal portion an equally complete polarization is effected without, in common practice as well as in theory, the advantages attained by a unilateral illumination from one edge only of the reflector. In applying the same law to the use of transmitted light for transparent objects, it is advised to place the lamp in such a position that its rays shall fall upon the mirror at an angle of about $54\frac{1}{2}°$ in order that the reflected and refracted rays may be as perfectly separated as possible. To obtain the angle accurately in all these cases, it is advised to set the illuminating apparatus by the aid of a sector or a properly divided card. The employment of the silvered side reflector below the object, as a means of transparent or of dark ground illumination, is mentioned as giving a clear soft light and excellent definition at any desired angle of incidence, no claim being made that its use should be limited to any special angle; a judgment in which all who have been accustomed to use this little instrument as a substage accessory will be likely to cordially concur.

Pollen Tubes for the Microscope. — Mr. J. O'Brien's remarks on this subject, quoted from the *Garden* by the *Monthly Microscopical Journal*, represent that he always failed to succeed in obtaining pollen tubes by dissecting the fertilizing stigmas, though spending much time in the effort, and that he had always seen similar failure attend the labors of others. He therefore recommends that the tubes be obtained on a slide by means of the nectar which appears on the stigma at the time of fertilization. The centre of a common microscope slide is touched to the drop of nectar on the stigma, care having been taken to prevent previous pillage by insects, and the spot of nectar thus obtained on the slide is touched by a mature anther so as to leave a few pollen grains on it. In about half an hour a projection like a fleshy root may be seen to grow from the end of each pollen grain; and after an hour or two each tube will be long and snake-like, the grain still attached and representing the head. The rotation of the contents of the tube may now be observed, the fluid passing down one side of the tube and returning on the other side. Temperature and moisture should be carefully controlled, as the growth depends on the fluid condition of the nectar. When sufficiently developed the object may be immediately mounted by pressing down upon it a cover glass, the nectar soon hardening and forming a mounting material in which the pollen is well shown. Specimens prepared in this manner a year ago are still perfectly preserved. The author presumes that any plant which produces the nectar in sufficient quantity may be treated in this way, though he has succeeded best with bulbous plants, Lilium, Hymenocallis (Pancratium), Crinum, etc. It would be an interesting and useful field for in-

vestigation to determine what artificial preparation could be made to take the place of the natural nectar in these experiments, as a means of obtaining and mounting the pollen tubes of flowers.

San Francisco Microscopical Society. — This society, one of the most prosperous in the country, having outgrown its old quarters, has just moved to new rooms in the building known as the Thurlow Block, corner of Kearney and Sutter streets. The rooms, which were first occupied on occasion of the regular meeting of November 2d, are on the fourth floor, approached by means of an elevator, and consist of a handsomely furnished meeting-room supplied with book-cases and cabinet to contain the rapidly increasing collections of objects and books belonging to the society, and an adjoining room fitted up as a laboratory with abundant facilities for microscopical work.

SCIENTIFIC NEWS.

— Professor James Orton left home during the middle of October for South America, with the intention of exploring the Beni River in the interests of geographical science, natural history, and commerce.

— Under the title Entomologischer Kalender für Deutschland, Oesterreich und die Schweiz, Dr. F. Katter, of Putbus, Germany, has published a very useful pamphlet, containing a diary for 1876, a list of German, Austrian, and Swiss entomologists and entomological societies and journals.

— J. Munsell, Albany, announces for 1877 The Indian Miscellany; containing papers on the history, antiquities, arts, inventions, languages, religions, traditions, and superstitions of the American aborigines; with descriptions of their domestic life, manners, customs, traits, governments, wars, treaties, amusements, exploits, etc.; also sketches of travel and exploration in the Indian country, incidents of border warfare, journals of military expeditions, narratives of captivity, anecdotes of pioneer adventure, missionary relations, etc. Collected by W. W. Beach.

— The well-known London house of Macmillan & Co., publishers of *The Practitioner*, have undertaken the publication in England of Micro-Photographs in Histology, the monthly work conducted by Drs. Seiler, Hunt, and Richardson. A large edition is required by the English profession.

— F. A. Curtiss, of Jacksonville, Fla., can supply the ornamental Florida grasses and air plant (Tillandsia), so much prized for parlor decorations, sea-weeds, wood encrusted with barnacles or burrowed by the teredo, coquina rock, river shells, sea-fans, sea-willow, stag's horn and other corals, sea beans, and anything else in the line of Florida curiosities, including stuffed or live alligators, alligators' teeth and eggs, stuffed birds, etc.; also, views of Florida scenery. The first-mentioned will be *exchanged* for Algæ, curiosities, and articles of use to a naturalist.

— Arthur F. Gray, Danversport, Mass., is desirous of obtaining specimens of *Purpura lapillus, Littorina litorea, L. tenebrosa, L. rudis, L. palliata, Tritia trivittata, Ilyanassa obsoleta,* and *Buccinum undatum* from all localities where they exist. He would like fifty specimens or more of the commoner species, if convenient, from each locality, together with notes in regard to the situations where such specimens were gathered. In collecting specimens, select a fair representative of each species, both small and large specimens. His object is to study the variations of mollusks which are either very common or distributed over extended areas, and then produce a paper upon their variations. Due acknowledgment will be made for any aid rendered.

— Lieutenant Cameron has been created a Companion of the Order of the Bath, and has been promoted to the rank of commander in the British Navy. The narrative of his travels, which will form the most interesting and important work on African geography that has appeared for many years, is now approaching completion. It will be published by Messrs. Daldy and Isbester, London.

— Several sets of plants collected by Dr. Palmer in Arizona and Northeastern California, determined by Professor Gray and Mr. S. Watson, are for sale at ten dollars a hundred. Apply to Dr. C. C. Parry, Davenport, Iowa.

— Dr. William LeBaron, late State Entomologist of Illinois, author of four annual reports on the injurious insects of that State, died October 14, 1876, at Elgin, Illinois. He was the son of Dr. Lemuel and Martha LeBaron, and was born in North Andover, Mass., October 18, 1814. He studied medicine with Dr. Joseph Kittredge in North Andover, and practiced there. He married Sarah Jarvis Carr, of Ellsworth, Maine, and in 1844 removed to Geneva, Illinois, where he also practiced medicine.

— The New York Aquarium was opened October 10th, under excellent auspices, a large number of friends of science meeting in the fine building erected for the purpose, and listening to an inaugural address by Hon. R. B. Roosevelt. Our readers will take a personal interest in this important enterprise from the liberal and scientific spirit that thus far has characterized the management. The manager and projector, Mr. W. C. Coup, directs the attention of the public to a feature of the New York Aquarium which he announces is "specially designed to promote and encourage original scientific research, and aid in the study of natural history in all of its most important branches. This consists in the establishment of a free scientific library and reading-room, as an adjunct to the Aquarium, together with a naturalist's workshop, fitted out with all the needed modern appliances, including microscopes, experimental tanks, dissecting tables, etc. This department is under the immediate charge of Mr. W. S. Ward, at whose suggestion it was established, and we propose to admit to the privileges of this scientific quarter any and

all of those who, either as students or teachers, may desire to avail themselves of the advantages of study and research here afforded."

Conducted in this spirit, and with the patronage of an intelligent public, we may hope for most excellent results. It affords the only means in the country for the study of the development of marine animals during the winter months, and affords a rare opportunity to naturalists in the city of New York, whom we personally envy.

PROCEEDINGS OF SOCIETIES.

IOWA ACADEMY OF SCIENCES, Iowa City.—June 23d. Prof. C. E. Bessey presented A Preliminary Catalogue of the Lichens of Iowa. His list of twenty-six species, collected principally in Central Iowa, includes probably about one fifth of the entire lichens of the State. He presented also A Preliminary Catalogue of the Orthoptera of Iowa, including thirty-nine species found in Central and Southeastern Iowa.

Mounds and Mound-Builders was the subject of a carefully prepared paper by Dr. P. J. Farnsworth, of Clinton, tending to show that the mound-builders were identical in race with the historical Indians of North America. The evidence offered was mainly based on resemblances in anatomical structure and modes of burial between the mound-builders and still existing Indian tribes.

Prof. Samuel Calvin, of the state university, described seven New Species of paleozoic Fossils, found mainly in Howard and Floyd counties, Iowa. He also presented a Notice of a Probable new Species of Elephant, from the modified drift near West Union, Iowa. The structure of the teeth differs from that of either *Elephans Americanus* or *E. primigenius*.

Prof. F. M. Witter presented Notes on the Land and Fresh-Water Shells found near Muscatine, of which he has determined fifty-two species.

The Deposits of the Chemung Group in Iowa were described by Professor Calvin as occupying a narrow area along the south side of Lime Creek for a few miles above Rockford, Floyd County, Iowa. It was shown that forty-five of the fossils of the group do not occur in other rocks in Iowa, and this together with the position of the deposits renders it proper to refer the group to a period above the Hamilton or to the Chemung. The further fact that three fourths of all the fossils in the group have been found nowhere else in the world, justifies the application of some distinctive title to the epoch, and the name "Rockford Shales" was proposed.

Professor Calvin also presented A Preliminary Notice of the Occurrence of Marcellus Shales in Iowa. This paper had reference to the discovery of a dark, somewhat bituminous shale beneath the Hamilton

limestone at Independence, Iowa. One of the shells found in this shale belonged to a genus that began its existence, so far as known, in the Marcellus shales, and this fact together with the position of the shale, justified its reference to the Marcellus epoch. The discovery of this shale with its carbonized plants explains the numerous reports that have gained circulation at various times, concerning the discovery of coal in regions occupied by Devonian rocks.

Professor Bessey read a note on The Colors of Iowa Wild Flowers, presenting tables prepared with a view of determining what influence the total amount of light and heat exerts on the predominant colors of the native Flora.

ACADEMY OF NATURAL SCIENCES, Philadelphia. — August 8th. Mr. Thomas Meehan referred to observations he had made this season on the nocturnal and diurnal expansion of flowers, and said that, contrary to the popular impression, it was not probable that light or its absence alone determined the opening of the blossoms. There were some plants, as for instance *Œnothera biennis* (the evening primrose), *Anagallis arvensis* (the pimpernel), and others, which remained open or otherwise, longer when the weather was humid or clear, and were looked on in consequence as a kind of floral barometers; but from other facts it was clear that it was not the weather merely, but some other incident accompanying the weather, which governed the case.

Though *Œnothera biennis* and other Œnotheras opened at evening, and if the atmosphere was moist would continue open the greater part of the next day, many species opened only in the daytime, and this they did regularly, quite regardless of meteorological conditions. *Œnothera serrata* of Colorado was one of these. It was regular in opening about noon, and the blossoms were all closed long before sundown.

In other allied families we saw similar divergences. In the cactus family Opuntia and Mammillaria opened only about midday, while most of the Cereus opened at night. The night-blooming cactus was a familiar example. But the chief interest was in the fact that many had their special hours of day or night for the expansion. The *Portulaca oleracea* (common purslane) opened about eight A. M., and by nine o'clock had performed all its functions, while a closely allied plant, the *Talinum teretifolium*, from the serpentine rocks of Chester County, opened at one P. M. and was closed by three o'clock. The conditions of the weather did not seem to influence them.

There was the same attention to daily periods in the growth of the parts of plants as well as in the expansion of the petals. In composite plants the floral growth was wholly in the morning, and was usually all over by nine or ten o'clock A. M. The elongation and expansion of the corolla was usually completed in an hour after sunrise, but the stamens grew for an hour more, and the pistils continued for still another. There was little if any growth in the floral parts after nine o'clock in a very

large portion of this order of plants. In grasses, Cyperaceæ, and some rushes also, the floral parts were very exact in their time of opening. In the plantains, Plantago, the pistils appeared a day or more in advance of the stamens, and these last appeared at about a regular time in each day. In *Luzula campestris* he had by a series of observations timed it exactly. Before nine the anthers were perfect, but by ten the pollen had been all committed to the winds and only dried matter remained. So far as he could ascertain, meteorological conditions did not influence the time in the least, in this case.

August 15th. An interesting communication from Dr. Charles Pickering on photographs of Tasmanians at the Centennial Exposition was read by the president. Dr. Pickering has been enabled by means of these portraits to refer the originals to the Papuan race or large New Guinea negro.

Mr. Martindale called attention to the genus *Opuntia*, the only genus of Cactaceæ found east of the Mississippi in the Northern States. Dr. Engelmann describes one species under the name *Opuntia Rafinesquii*, which includes two or three of the species described by Rafinesque. Mr. Martindale had collected in the neighborhood of Haddonfield, N. J., what he believes to be *Opuntia vulgaris*, a species which Dr. Engelmann had not before seen from any locality north of the Falls of the Potomac. The characters of the two species were described and contrasted. A specimen from Woodbury, N. J., was decided to be *Opuntia Rafinesquii*, as were also those from the neighborhood of the coast. Mr. Redfield had heretofore doubted the existence of *Opuntia Rafinesquii* in this quarter, and now believes that the form so called was but a variety of *Opuntia vulgaris*.

Dr. Allen called attention to a deformation in a domestic cow similar to that described by him recently as existing in a Brahmin bull. In the case under consideration a supernumerary anterior limb grows from the shoulder, but it ends in one toe only, instead of three, as in the former case. There is, however, a rudimentary toe and a small protuberance farther up the shaft of the metacarpus.

August 29th. A paper entitled Note on the Discovery of Representatives of two Orders of Fossils new to the Cretaceous Formation of North America, by Wm. M. Gabb, was presented for publication.

September 6th. A paper entitled On the Lingual Dentition, Jaw, and Genitalia of Carelia, Onchidella, and other Pulmonata, by Wm. G. Binney, was presented for publication.

Mr. Meehan called attention to a specimen of an exceedingly curious plant, *Welwitschia mirabilis*, on exhibition in the Portuguese African Section of Agricultural Hall, Centennial Exhibition. He also spoke of his observations upon *Mentzelia ornata*. The plant blooms at night. The flowers open for four nights in succession, after which they cease to do so. One flower was covered with gauze and found to produce seed as freely as those not so protected.

Dr. Asa Gray suggested that the capsules might be swollen without containing perfect seeds.

September 20th. Dr. Leidy spoke of the structure and habits of certain fresh-water rhizopods. In the genus *Hyalosphænia* the test or shell is homogeneous and transparent. Several species have been described, one of which had been discovered in the Sphagnum swamps of New Jersey, and from its resemblance to a butterfly, when the pseudopods or arms are extended, it had been named *Hyalosphænia papilio.* Pores were found to exist in the shell, through which the water passes in and out as the body dilates and contracts. Foreign substances adhere to the naked Amœbas on the part of the body opposite to that from whence the pseudopods are protruded. A sluggish *Amœba* had been observed to swallow rhizopods with shells, and, after digesting the soft parts, the calcareous covering was ejected. Others had been observed to select specimens of diatoms having green digestible matter in their interior, from those which were not possessed of such nutritive material.

At the request of Mr. Meehan, Dr. Engelmann, of St. Louis, spoke of the characters and geographical distribution of *Abies Fraseri.* It closely resembled the common balsam, *Abies balsamea.* The tree seems to be confined to the summit of a small number of mountains about six thousand feet in height. The most prominent distinguishing characters are found in the cones, which have protruding and recurved bracts. It has, however, been found that the microscopic structure of the leaves furnishes admirable distinctive characters. The peculiar structure of the leaves of all these trees allies them more closely to the ferns than to the higher plants. In *Abies balsamea* the cells under the epidermis which are devoid of chlorophyl or coloring matter are few in number, while in *Abies Fraseri* they are numerous and regularly distributed on the upper surface of the leaves. All the firs and many of the pines can thus be distinguished by the structure of the leaves alone. There are a great many plants in the mountains of North Carolina which are found only there. The name Black Mountains is due to the dark color of the *Abies Fraseri*, still more to *Abies nigra.*

Mr. Martindale spoke of the introduction of plants from other localities. He had within the past week collected specimens of *Leonurus sibiricus* at the mouth of the Wissahickon. It appeared to be perfectly naturalized in a space four or five feet square. Mr. Redfield suggested that the seeds might have come in the foreign wool used in the mills farther up the river.

Mr. Canby noticed the rapidity with which *Lespedeza striata* had spread over the western part of North Carolina, Eastern Tennessee, and all over the Alleghany range.

Mr. Gesner spoke of the great benefit derived from the growth of *Lespedeza striata* on pasture lands throughout the Southern States. It grew everywhere luxuriantly, and was eagerly eaten by cattle. It is salivating when eaten by horses, but not so when used by mules.

In continuation Dr. LeConte noticed the increase of introduced species of Coleoptera. One species of *Aphodius*, from the Gulf of St. Lawrence, had extended downward to Massachusetts. Another had spread from Maine to Virginia. Other insects introduced into New England had remained localized.

Mr. Gabb noticed the growth of an introduced plant, the Alfilarillo, *Erodium cicutarium*, in California.

September 26th. Mr. Martindale stated that the foreign plant spoken of by him as having been found at the mouth of the Wissahickon Creek had been determined by Dr. Gray to be *Leonurus glaucescens*. It comes from Siberia, and was probably brought among some of the Centennial exhibits, most likely by way of Japan. He did not think it came in wool, as suggested at a previous meeting.

Dr. Engelmann, of St. Louis, continued his remarks upon the conifers. These plants are found much earlier in geological formations than ordinary flowering plants, which is an additional reason for placing them below the latter. Peculiarities of wood and seed, as well as those of the leaves previously described, were dwelt upon, and the conclusion was reached that these plants stand as a connecting link between the endogens and the exogens.

Dr. McQuillen directed attention to a human skull in which, owing to the loss of the bicuspid and molar teeth in the left side of the lower jaw, an upper molar, failing to meet with the antagonizing tooth, protruded from its socket twice its original length. In addition to this, and from the same cause, the left upper jaw had fallen considerably below the level of the right side, and had in consequence lowered the orbit to such an extent as to produce marked disfigurement during life. The condition of this skull was contrasted with that of one in which all the teeth were in good condition, symmetrical in their arrangement, and illustrating in a marked degree the harmony of antagonism.

October 3d. Dr. Leidy spoke of the results of a dredging excursion on the Schuylkill River. The mud at the bottom of the river was found to be thoroughly saturated with coal-oil, and in consequence thereof all the animal and vegetable life, which the dredging party had expected to find in abundance, had been destroyed. It was believed that this absorption of the coal-oil by the river mud exemplified the formation of bituminous shale.

Dr. LeConte remarked that the only difference between the modern and the ancient bituminous bearing deposits was that in the case of the former the oil came from the refuse matter of the manufactories, and in the earlier formations it was absorbed immediately when exuded by the substances producing it. The origin of these oils from vegetable sources was alluded to.

Rev. Mr. McCook spoke of the architecture and habits of a species of ant, *Formica rufa*. The mature hills formed by these ants were

forty inches in height, thirty-six feet in circumference at the base, and eleven feet at the top. They had probably taken seven years to grow to this size. On account of the dryness of the season, little activity was at first observed among the builders, but a shower of rain commencing to fall, they immediately began to work. The mode of formation of the hills and galleries was described and illustrated by drawings and photographs. It was believed that no liquid was used in building the arches, but the pellets of which they were constructed were dovetailed into each other, and rain seemed necessary to cement the work. The greatest regularity in the galleries seemed to be north and south, while the long slope of the hills was towards the west. This did not seem to be at all dependent upon the direction of the wind, but appeared as if the ants actually build with regard to the points of the compass. The doors of the galleries were not closed at night, as described by Huber. Peculiarities of structures made by ants of the same species in Delaware County and at Rockland were described.

Dr. Leidy spoke of the destruction of plants by ants in the neighborhood of their nests, either by the action of formic acid or by eating the roots. He had observed that a species of grass, *Aristida*, was exempt from this destruction. Whether the ants allowed it to remain for the purpose of strengthening their structure, or because they did not find it palatable, he could not decide.

Mr. McCook stated that the ants observed by him extruded formic acid very vigorously, and he had observed yellow tracks on the trees, which might be owing to this cause.

Dr. Koenig remarked that formic acid would produce a natural cement with the calcareous particles of the mounds.

Dr. Chapman stated that the length of the cæcum given off from the rectum of an ostrich recently examined by him was thirty-five inches. It was believed that the comparative length of this part of the intestine seemed to depend upon the nature and amount of the food.

Mr. Meehan spoke of the *Akebia quinata*, an indigenous plant of Japan, where it bears fruit, although it had not been known to do so in this country until recently, when the fruit had been produced by a vine cultivated by Mr. Canby, of Wilmington, Del.

Mr. Meehan also exhibited a specimen of rare fungus of the genus *Phallus*, which he had recently found on his grounds for the first time in seven years. Its peculiar odor attracted meat flies in considerable numbers. The bearing of the facts spoken of upon the question of insect agency in fertilization was dwelt upon.

Dr. Leidy related his observations upon a species of *Phallus*, and mentioned the fact that insects carried the spores from place to place. The power of insects to convey gangrene and other poisons was spoken of in this connection.

The president announced that the Biological and Microscopical Section

of the Academy proposed giving a microscopical exhibition on the 16th inst.

The following papers were presented for publication: Note on *Ptiloris Wilsonii* Ogden, by James A. Ogden, M. D.; On the Extrusion of the Seminal Products in Limpets, with some Remarks on the Phyllogeny of Docoglossa, by Wm. H. Dall.

October 10th. Dr. LeConte spoke of some larvæ of beetles received from Mr. J. A. Lintner, of New York, which were said to be very destructive of carpets in Albany and the neighboring towns. They were determined to belong to the Dermestidæ, and on further investigation were decided to be the *Anthrenus scrophulariæ*, a European species which had not before been found in this country.

Dr. LeConte called attention to an observation he had seen published to the effect that finely powdered corrosive sublimate scattered upon ant hills drove the inhabitants to an insane rage, when they would fall upon each other and become involved in an inextricable mass, from whence none would escape alive.

ACADEMY OF SCIENCE, St. Louis. — October 2d. Mr. Riley made a communication on the insect pests at the Centennial Exposition.

October 16th. Professor Potter gave the results of his analysis of Peruvian lignite.

ACADEMY OF SCIENCES, New York. — October 16th. Mr. Alexis A. Julien read some Observations on Prehistoric Remains in Western North Carolina. Prof. Thomas Egleston read a paper entitled Vein Accidents in the Lake Superior Region.

BOSTON SOCIETY OF NATURAL HISTORY. — October 4th. Mr. Charles S. Minot read a paper on the Relationship of the Vertebrates and Worms, and Prof. A. Hyatt gave a description of an interesting Tubularian Hydroid.

October 18th. Dr. T. Sterry Hunt made a communication on the Geological Succession of the Crystalline Rocks.

APPALACHIAN MOUNTAIN CLUB. — October 11th. Mr. Wm. G. Nowell gave an account of an exploration of Carter Dome, near the Wild Cat River. He gave a detailed description of the route adopted and of the observations made there. The mountain and those about it he proposes to call the Carter Dome Group, and says that two or three days' work upon the top of the principal mountain will enable the club to obtain an uninterrupted view of all the encircling country. Mr. W. H. Pickering read a paper upon distant points visible from the White Mountains, in which he said it was possible to obtain two hundred and eighty views from Mount Washington, one hundred and twenty-one from Moosilauk, forty-three from Passaconway, and twenty-three from Mount Lafayette. An interesting discussion took place as to whether Katahdin is visible from Mount Washington. Professor C. E. Fay also read a paper concerning Black Mountain, alias Sandwich Dome, in which he favored an adherence to the old name as especially fitting and proper.

SCIENTIFIC SERIALS.[1]

THE GEOGRAPHICAL MAGAZINE. — November. The Arctic Expedition. On Foot through Central Japan, by E. R. Crooke. J. Bonnat's Exploration of the Volta. Sketches of Life in Danish Greenland. The German Expedition to Northern Siberia. The Expedition to the Lena and Olenek, by A. L. Chekanooski.

THE GEOLOGICAL MAGAZINE. — October. On the Tertiary Fish-Fauna of Sumatra, by A. Günther. On *Harpactes velox*, a Predaceous Fish from the Lias of Lyme Regis, by Sir P. Grey-Egerton. The Climate Controversy, by S. V. Wood, Jr. Theories of the Formation of Rock-Basins, by H. Miller. Ground-Ice as a Carrier, by H. Landor. — November. On the "Gondwana Series," and the Probable Age of the Plant-Beds of India, by O. Feistmantel. On the Motion of Glaciers, by J. F. Blake. List of Described American Insects from the Carboniferous Formation. Orthoptera, by S. H. Scudder.

MONTHLY MICROSCOPICAL JOURNAL. — November. On the Microscopical Structure of Amber, by H. C. Sorby. Diatomaceæ in Slides of Santa Monica Deposit, by F. Kitton. The Present Limits of Vision, by Dr. Royston-Pigott. Comparative Photographs of Blood-Discs, by G. Gulliver. On the Structure and Development of Connective Substances, by T. E. Satterthwaite. — December. On a New Method of Measuring and Recording the Bands in the Spectrum, by T. Palmer. On the Measurement of the Angle of Aperture of Object-Glasses, by F. H. Wenham. Experiments with a Sterile, Putrescible Fluid, exposed alternately to an optically Pure Atmosphere and to one charged with known Organic Germs of extreme Minuteness, by W. H. Dallinger. On a New Refractometer for Measuring the Refractive Index (Mean Rays) of Thin Plates of Glass, Lenses, Wedges, and also of Fluids placed in Cavities or Tubes, by Dr. Royston-Pigott. The Gladiolus Disease, by W. G. Smith.

ERRATA. — Vol. x., page 634, first and second lines from bottom, page 635, second line from top, for *venation* read *vernation*.

Page 729, thirteenth, fifteenth, and twenty-eighth lines, for *Wales'* read *Wale's*.

Page 729, last line, omit the comma after "Powell."

Table of contents, third page, last line, for *Nichols* read *Michels*.

[1] The articles enumerated under this head will be for the most part selected.

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SOME ACCOUNT OF THE NATURAL HISTORY OF THE FANNING GROUP OF ISLANDS.

BY DR. THOMAS H. STREETS, U. S. N.

THE collection of islands which we have here designated by the name of Fanning's Group consists of four coral islands situated in the Pacific Ocean, immediately north of the equator. I am not aware that they have ever been grouped on any chart, but, inasmuch as they form a natural group, and as three of them were discovered by Captain Edmund Fanning, an American sailor, I think we are justified in describing them under the above title. They stretch from latitude 1° 57′ N. to 5° 49′ N., and from longitude 157° 27′ W. to 162° 11′ W., and, like most other groups in the Pacific, their general direction is northwest and southeast, thereby conforming to the general trend of the submarine range of mountains whose peaks they cap. As their formation is purely coral, their geological structure is comparatively simple.

The most westward, and evidently the last formed of the group, is Palmyra. Caldew Reef, forty miles to the northward of Palmyra, has hardly, as yet, assumed the distinctive features of an island. It is entirely under water at high tide, and but a few coral heads project here and there above the surface at low water. In the course of time, however, it will undoubtedly be added to the group. Palmyra represents the second stage in the formation of a coral island. The winds, waves, and currents, assisted probably by some other agents, have been at work on the surface coral, and have ground it and piled it up beyond the reach of the highest tides. It now consists of fifty-eight small islets, thickly clothed with vegetation, arranged in the form of an elongated horseshoe opened to the westward, and inclosing four lagoons. The islets are separated one from another by nar-

row, shallow channels, through which the water of the ocean finds free access to the lagoons. In a completed atoll the rim of land inclosing the lagoon is unbroken, but in the greater number of coral islands a narrow lagoon-outlet is always found on the western side.

A broad, interior shore platform of fine coral sand extends, in places, from one side of the island to the other, and forms distinct boundaries for the lagoons, and connects together most of the islets. It also forms a barrier to the westward, approximating the two extremities of the horseshoe, leaving the lagoon-outlets so very narrow and shallow as hardly to admit of the passage of a ship's boat. The outer shore platform is about three hundred feet wide, and is covered with coarse coral blocks.

The island is being gradually extended to the westward. From the two ends of the horseshoe the water breaks out for a mile or more, and from the northern end it shoals around in a curve to the southward for three or four miles. This, too, in years to come, will be elevated above the surface and another body of water will be inclosed, forming a lagoon where vessels now ride at anchor.

Very scanty evidence of any agents having been at work in building up the land other than the coral animal and the action of the waves are observable anywhere about the island. The highest point is only seven feet above high water. In no place has the reef-rock been upheaved. But an elevation of a few inches might be supposed from the position of the rock of beach formation, which in places has been lifted up horizontally out of the reach of the tides.

The eastern islets are the oldest in formation. That this is true is evident from several facts. In the first place, the vegetation there is denser and ranker, and more genera are represented than on the islets to the leeward. All the plants that were found growing on the latter islets also exist on the eastern, with the addition of several species that have not yet been diffused to the westward, showing that the germs of life started into existence in the east, the direction of the prevailing wind and current. A further proof of this is shown in the condition of the cocoanut-trees in the different localities. This tree when young is bulbous at the base, a condition which is observable in all the trees on the western islets, while on those to the windward they are taller and the trunks have nearly the same diameter from the base to the crown.

Washington Island, the most remarkable of the group, presents several very interesting geological features. The evidences of the operation of some great disturbing agent are more plainly visible here than elsewhere. Either this force must have been extremely local in its operation, or else it was exerted upon the member of the group which we have just considered when it was in such a condition as not to show it. The latter hypothesis is the most reasonable. Washington Island is an obliterated atoll. In the place of the usual salt water lagoon there is a lake of fresh water, one mile long and half a mile wide, with a depth of four fathoms in its deepest part. No shore platform makes out from the land at low water, but the sea at all stages of the tide breaks directly on the beach, except at the angles of the island where reefs extend a certain distance into the sea. The beach shelves rather abruptly to the water's edge. The highest part of the land is about fifteen feet high, and over all the interior of the island there are outcroppings of the reef-rock and the rock of beach formation. All traces of the former passage from the sea into the lagoon have been obliterated. The salt water of the lagoon has either drained off through the light, porous soil, or has been freshened by the immense rain-falls which occur in these latitudes. The latter event is not improbable, considering the situation of the island on the edge of the trades, in the region of variable winds, where rains are frequent and heavy.

In time past, the rim of land inclosed three lagoons. One, the largest, is now the lake; the others are about half the size of the first, and are converted into peat-bogs. The latter are thickly overgrown with rushes and contain a solid deposit of vegetable matter three or four feet deep, composed of the roots, trunks, and *débris* of the cocoanut and pandanus trees closely matted by the roots of the rushes. The time of our visit was just after a heavy rain, and a layer of water from six to eighteen inches deep covered the surface of the bogs.

The island supports a dense and luxuriant growth of vegetation, and a greater number of species are represented there than on any of the other islands of the group.

The water of the lake is just perceptibly brackish; and the only life it is said to contain are a species of eel and a shrimp, both of which we were told are different from anything found in the water surrounding the island. This information was derived from an intelligent Englishman, who had visited the island several times to superintend the gathering of the cocoanuts. They

are the kinds of life that we should look upon as being the first to adapt themselves to the altered condition of things. Unfortunately we were not able to procure a specimen of either. Our stay was so limited (but a part of one day was spent there), that we could not make as thorough an examination of the island as its interesting nature called for.

The richest results obtained in our brief visit were in the department of ornithology. The lake and peat-bogs were tenanted by a diminutive species of duck of the genus *Chaulelasmus*. *C. Couesi* we have named it, in honor of Dr. Elliot Coues. (Bull. Nuttall Orn. Club, vol. i. p. 46, 1876.) This is the second species of the genus known to exist. The other, *C. streperus*, the common gadwall, is almost cosmopolitan; the one is as restricted in its habitat as the other is wide-spread. The markings on the plumage of the two species are almost identical; they differ only in size, and in some minor details of bill and feet.

By far the handsomest of all the feathered tribe of the island is a little lory, the *Coriphilus kuhli*. It belongs to the Polynesian group of parrots, which are distinguished by the predominance of red in their plumage. Though not new to science, yet its discovery, or rather re-discovery, was an important event as determining its habitat. Finsch in his "Papagien" has the following concerning it: "This is one of the rarest parrots existing, only to be found in few museums. It was erroneously said by Wagler to come from the Sandwich Islands. Latterly this rare species does not seem to come to Europe at all, which is surprising, inasmuch as the Society Islands, which thus far have been regarded as their only home, have considerable traffic with Europe. As a special locality, Vigors mentions Tubuititiruba, near Tahiti: Lesson gives Borabora. Bourjot's specimen in the Paris Museum is said to have come from Fanning Island, northwest of Christmas, and northeast of the Phœnix group. But although everything is diametrically opposed to this assertion, it might nevertheless not be improbable that this very island is its true home." Fanning Island is one of this group, and is situated about seventy miles south of Washington Island. These two islands are without doubt the true habitat of this lory, and it is highly improbable that it ever came from any other locality.

The following untechnical description, which is copied from Fanning's Voyages, is sufficient to prove that *C. kuhli* inhabited Fanning's Island at the time of its discovery in 1798. "Amongst

the birds was one species about the size of our robin, with a breast of scarlet colored feathers, the under portion of the body being finished off with bright red, the neck of a golden color, back of a lively green, with a yellow beak, except the very points, which were of a bright dun color, the wings and tail being both of a jet black, and the last tipped off with white ; it was a most beautiful and lovely bird with its brilliant and richly variegated plumage."

They were reasonably abundant on Washington Island, and when I signified a desire to a native of the Kingsmill group to have some of the birds alive, he gratified me in the following manner : He took two pieces of bamboo, each about a yard long. On the end of one he perched a tame bird, and from the extremity of the other suspended a running noose. The tame bird, as it was carried about among the cocoanut-trees, uttered a harsh, rasping sound, and wild birds came out of the trees and perched alongside it on the bamboo, when, by means of the other stick, they were carefully noosed.

When caged aboard the ship, they exhibited as pretty a picture of love as one can imagine, well meriting their name of "love-birds." They sat billing and smoothing each other's feathers for hours, and as night came on two would get together, and sleep with their heads turned towards each other. They lived in confinement but a very short time, and bore it badly. Even while we stood watching their lively antics one would tumble off its perch and die, apparently in convulsions.

The only other land bird found on Washington Island belonged to the *Passeres.* It was a flycatcher-like bird. As many of these as were seen were procured, but the specimens were sent home from the Pacific, and before I arrived east to commence the work of identification, they were distributed through the general collection of the Smithsonian Institution and have not yet been found. This is to be deplored, for they would probably be as interesting as the other species obtained from the same locality. A bird similar to these, but smaller and somewhat browner — which I think can be accounted for by the altered conditions of its surroundings — was found on Christmas Island, where it was the only land bird. But this, like the previous species, is mislaid in the collection at Washington.

Christmas Island was discovered by the great English navigator, Cook, and it has been visited a number of times by exploring expeditions. It is therefore not such a *terra incognita* as the ones we have been considering.

It is the largest island of the group, and is situated the furthest to the eastward and southward, in close proximity to the equator. It consists of a narrow rim of land, thirty miles in circumference, inclosing an immense lagoon. All of our research was limited to the western side.

There are unmistakable evidences of an elevation beyond the height to which land can be built up by the waves and tides. North of the lagoon entrance a distinct old beach line could be traced running parallel to an ancient shore ridge, and distant about two hundred yards from the water of the present lagoon. The shore ridge, about twelve feet high, runs north and south, and is about one hundred yards from the sea-beach. Between the ridge and the beach the surface is thickly strewn with coarse coral blocks of the old shore platform. At the time when the sea washed over this platform it was separated from the water in the lagoon only by the breadth of the shore ridge. A tract of land, from two to three hundred yards in width, has been added to the island by upheaval. The massive reef-rock is elevated all along the present shore line. The highest land is from fifteen to twenty feet high.

This island is far removed from the others in its local conditions; there is no fresh water, it rarely or never rains, the vegetation is low and scanty, — the densest of it hardly casting a shadow, — and the white coral sand glows with the direct rays of the sun's heat. It was interesting to note the changed habits of the birds under these altered surroundings. In December, on Palmyra, the gannet (*Sula piscator*) had finished the period of its incubation, and the young were large-sized; on Christmas Island, one month later, we found the same species still sitting on their eggs, and few or no young were seen. These birds were observed to have a very curious habit in the latter locality, which they were not seen to possess on Palmyra. They constructed their nests on the low shrubbery, and under each nest was a mound, two or three feet tall, composed of twigs, and solidly cemented together by their excrement. They evidently occupy the same nest for several successive seasons, — for the lean bushes would hardly furnish a sufficient quantity of twigs to build up the mounds in a single season — and it may be they amuse themselves, while sitting on their eggs, by breaking off all the small branches within reach of their beaks and dropping them under their nests.

The other birds are equally backward in the performance of their marital duties. On Palmyra the *Gygis alba* and the noddy

(*Anous stolidus*) lay their eggs; the former on the naked branches of the trees, which in some instances are hardly greater in diameter than the egg itself, and the latter in well constructed nests of twigs in the forks of the branches of the tall trees. On Christmas Island the larger coral blocks answer the purpose of the first named, and a shallow concavity scooped in the bare ground that of the last.

Most birds are guided by their instinct of self-preservation in selecting a site for the construction of their nests; in fact, I may say this seems to be a law. But in this case there is nothing on the one island, not found on the other, which would drive them to adopt these widely different habits. It is evident that they simply conform to their surroundings. The ground and coral blocks are both present on Palmyra, yet they choose the trees in preference, being guided probably by their taste rather than by a desire for protection.

The sooty terns (*Sterna fuliginosa*) were breeding on Palmyra. Their chosen locality is the extreme eastern point of the island, on the bare clinker beach, almost within reach of the breakers. They make no attempt to construct a nest; nor do they so much as scoop a hole in the ground to receive their eggs, which are dropped apparently anywhere. They live as a community by themselves during the breeding season, and so great are their numbers that they form a cloud when driven from the ground, and their clamor deadens the roar of the surf.

The *Sula cyanops* was breeding on Christmas Island. A few of the same species, all in immature plumage, were nesting on Palmyra. The old and the young were in no instance found nesting together on the same breeding ground; the former were confined to Christmas, and the latter to Palmyra Island. Is it possible that the young individuals are ostracized until they robe themselves in the fashionable dress?

The only other birds found breeding on Christmas Island were the red-tailed tropic-bird (*Phæthon rubricauda*), the *Æstrelata parvirostris*, and a new species of puffin (*Puffinus*), not yet described. The bristly-thigh curlew (*Numenius femoralis*), the golden-back plover (*Charadrius fulvus*), the *Totanus semipalmatus*, and a species of *Tringa* were common to both islands, but were more numerous on Palmyra. The same statement may be applied to the lesser frigate bird (*Tachypetes Palmerstoni*).

These birds constitute the whole avifauna, and are almost the

only life of the islands. The sea-birds range away from the land, in pursuit of their finny prey, to a distance varying from sixty to eighty and sometimes even to a hundred miles; and so unerring are they in their return to their breeding and roosting places, that we were told the captains of the small schooners, who seek the islands to harvest their crop of cocoanuts and to look about for guano, find the objects of their search by laying to, when they imagine themselves somewhere in their vicinity, until evening, when the birds wing their way homeward, and then shaping their course by the direction of the flight of the birds.

The other terrestrial animals of Palmyra are a minute shell, a *Tornatellina*, that clings to the under surface of the fronds of the *Polypodium aureum*, and a land leech that fastens itself to the eyelids of the young birds.

A soldier-crab (*Cœnobita Glivieri*) quits the water and lives on the land at certain seasons of the year, and it may therefore be properly considered terrestrial. They are ubiquitous; they climb the trees and bushes, dragging after them the heavy shells of the *Turbo argyrostoma*.

Washington Island is a home of the gigantic *Burgus latro*. "In the Pacific this species, or one with closely allied habits, is said to inhabit a single coral island north of the Society group." Since this statement of Darwin's was made, we have gained a much better knowledge of its distribution, so that now it may be said there is scarcely a group of islands in the Pacific Ocean where it is not found. The stories about this crab climbing trees after cocoanuts are entirely unfounded. It lives in burrows in the ground, and feeds on the cocoanuts as they fall from the trees. It first strips off the husk, shred by shred, and then, with its strong pincers, breaks through the shell at the extremity that holds the eyes. The strength of their claws is sufficient to crush a lath in twain, and so tenaciously do they hold on to anything when once they have obtained a grip, that I have known them to hang suspended from a tree for an hour or more, holding on by their claws. Sometimes the unwary native, in searching their burrows with his hand for the fine cocoanut husk which forms their bed, is surprised to find his fingers in the vice-like grasp of the crab; and it may be interesting to know that in such a dilemma a gentle titillation of the under soft parts of the body with any light material will cause the crab to loose his hold. They are said to visit the sea at night for the purpose of wetting their branchiæ.

EXPLORATIONS MADE IN COLORADO UNDER THE DIRECTION OF PROF. F. V. HAYDEN IN 1876.

FOR reasons beyond the control of the geologist-in-charge, the various parties composing the United States Geological and Geographical Survey of the Territories did not commence their field work until August. Owing to the evidences of hostility among the northern tribes of Indians, it was deemed most prudent to confine the labors of the survey to the completion of the atlas of Colorado. Therefore the work of the season of 1876 was a continuation of the labors of the three preceding years, westward, finishing the entire mountainous portion of Colorado with a belt fifteen miles in width of Northern New Mexico and a belt twenty-five miles in breadth of Eastern Utah. Six sheets of the physical atlas are now nearly ready to be issued from the press. Each sheet embraces an area of over 11,500 square miles or a total of 70,000 square miles. The maps are constructed on a scale of four miles to one inch with contours of two hundred feet which will form the basis on which will be represented the geology, mineral, grass, and timber lands, and all lands that can be rendered available for agriculture by irrigation. The areas of exploration are located in the interior of the continent, far remote from settlements, and among the hostile bands of Ute Indians that attacked two of the parties the previous year.

The point of departure the past season was Cheyenne, Wyoming Territory. The primary triangulation party was placed in charge of A. D. Wilson, and took the field from Trinidad, the southern terminus of the Denver and Rio Grande Railway, August 18th, making the first station on Fisher's Peak. From this point the party marched up the valley of the Purgatoire, crossed the Sangre de Cristo Range by way of Costilla Pass, followed the west base of the range northward as far as Fort Garland, making a station on Culebra Peak.

About six miles north of Fort Garland is located one of the highest and most rugged mountain peaks in the West, called Blanca Peak, the principal summit of the Sierra Blanca Group. On the morning of August 28th the party, with a pack mule to transport the large theodolite, followed up a long spur which juts out to the south. They found no difficulty in riding to the timber line, which is here about twelve thousand feet above the sea-level. At this point they were compelled to leave the animals, and, distributing the instruments among the different

members of the party, proceeded on foot up the loose rocky slope to the first outstanding point, from which a view could be obtained of the main peak of the range. Although this first point is only six hundred feet lower than the main summit, yet the most arduous portion of the task was yet to come. The main summit is about two miles north of the first point, in a straight line, and connected with it by a very sharp-toothed zigzag ridge over which it is most difficult to travel on account of the very loose rocks and the constant danger of being precipitated down, on either side, several hundred feet into the amphitheatre below. After some two hours of this difficult climbing, they came to the base of the main point, which though very steep was soon ascended, and at eleven o'clock, A. M. they found themselves on the very summit. From this point one of the most magnificent views in all Colorado was spread out before them. The greater portion of Colorado and New Mexico was embraced in this field of vision. This point is the highest in the Sierra Blanca group and so far as is known at the present time is the highest in Colorado. The elevation of this point was determined by Mr. Wilson in the following manner: first, by a mean of eight barometric readings taken synchronously with those at Fort Garland, which gave a difference between the two points of 6466 feet; secondly, by fore and back angles of elevation and depression, which gave a difference of 6468 feet. The elevation at the fort was determined by a series of barometric readings, which compared with those of the signal-service barometer at Colorado Springs gave it an elevation of 7997 feet, making the Blanca Peak 14,464 feet above sea-level. This peak may be regarded therefore as the highest or at least next to the highest yet known in the United States. A comparison with some of the first-class peaks in Colorado will show the relative height: —

	Above sea-level.
Blanca Peak	14,464 feet.
Mt. Harvard	14,384 "
Gray's Peak	14,341 "
Mt. Lincoln	14,296 "
Mt. Wilson	14,280 "
Long's Peak	14,271 "
Uncompahgre Peak	14,235 "
Pike's Peak	14,146 "

The foregoing table will afford some conception of the difficulty encountered in determining the highest peak when there are so many that are of nearly the same elevation. About fifty peaks are found within the limits of Colorado that exceed fourteen thousand feet above sea-level.

From this point the party proceeded westward across the San Luis valley and up the Rio Grande to its source, making two primary stations on the way, one near the summit district and the other on the Rio Grande Pyramid. From the head of the Rio Grande the party crossed the continental divide, striking the Animas Park, thence west by trail to Parrott City.

After making a station on La Plata Peak, the party marched northwest across the broken mesa country west of the Dolores, making three stations on the route to complete a small piece of topography that had been omitted the previous year on account of the hostility of the Ute Indians. After making a primary station on the highest point of the Abajo Mountains, the party turned westward to Lone Cone, where another station was made; thence, crossing the Gunnison and Grand rivers, they proceeded to the great volcanic plateau at the head of White River. The final station was made between the White and Yampah rivers in the northwestern corner of Colorado. During this brief season, Mr. Wilson finished about one thousand square miles of topography and made eleven geodetic stations, thus connecting together by a system of primary triangles the whole of Southern and Western Colorado.

In company with the triangulation party, Mr. Holmes made a hurried trip through Colorado, touching also portions of New Mexico and Utah. He was unable to pay much attention to detailed work, but had an excellent opportunity of taking a general view of the two great plain-belts that lie, the one along the eastern, the other along the western base of the Rocky Mountains. For nearly two thousand miles of travel he had constantly in view the Cretaceous and Tertiary formations, with which are involved some of the most interesting geological questions. He observed among other things the great persistency of the various groups of rocks throughout the east, west, and north, and especially in the west, for from Northern New Mexico to Southern Wyoming the various members of the Cretaceous formation lie in almost unbroken belts, while the Tertiaries are hardly less easily followed.

Between the east and the west there is only one great incongruity. Along the eastern base of the mountains the upper Cretaceous rocks, including numbers four and five, are almost wanting, consisting at most of a few hundred feet of shales and laminated sandstones. Along the western base this group becomes a prominent and important topographical as well as geological feature.

In the southwest, where it forms the "mesa verde" and the cap of the Dolores plateau, it comprises upwards of two thousand feet of coal-bearing strata, chiefly sandstone, while in the north it reaches a thickness of 3500 feet and forms the gigantic hog-back of the Grand River Valley.

While in the southwest he visited the Sierra Abajo, a small group of mountains which lie in Eastern Utah, and found, as he had previously surmised, that the structure was identical with that of the other four isolated groups that lie in the same region. A mass of trachyte has been forced up through fissures in the sedimentary rocks and now rests chiefly upon the sandstones and shales of the lower Cretaceous. There is a considerable amount of arching of the sedimentary rocks, probably caused by the intrusion of wedge-like sheets of trachyte, while the broken edges of the beds are frequently bent abruptly as if by the upward or lateral pressure of the rising mass. He was able to make many additional observations on the geology of the San Juan region and secured much valuable material for the coloring of the final map.

He states that the northern limit of ancient cliff builders in Colorado and Eastern Utah is hardly above latitude 37° 45′.

The Grand River Division was directed by Henry Gannett, topographer, with Dr. A. C. Peale as geologist. James Stevenson, executive officer of the survey, accompanied this division for the purpose of assisting in the management of the Indians, who last year prevented the completion of the work in this locality by their hostility.

The work assigned this division consisted in part of a small area, containing about one thousand square miles, lying south of the Sierra la Sal. The greater portion of the work of this division lay north of the Grand River, limited on the north by the parallel of 39° 30′ and included between the meridians of 108° and 109° 30′.

This division took the field at Cañon City, Colorado, about the middle of August. The party traveled nearly west, up the Arkansas River, over Marshall's Pass and down the Pomichi and Gunnison rivers to the Uncompahgre (Ute) Indian agency. Here they secured the services of several Indians as escort in the somewhat dangerous country which they were first to survey. This area lying south of the Sierra la Sal was worked without difficulty. It is a broken plateau country and presents many curious pieces of topography. Eleven days were occupied in this work.

The Grand River from the mouth of the Gunnison River to that of the Dolores, that is, for nearly a hundred miles, flows along the southern edge of a broad valley, much of the way being in a low cañon, one hundred to two hundred feet deep. The course of the river is first northwest for twenty-five miles, then turning abruptly it flows southwest, and then south for about seventy-five miles. This valley has an average width of twelve miles. It is limited on the north and west by the Roan or Book Cliffs and their foot-hills, which follow the general course of the river. These cliffs rise from the valley in a succession of steps to a height of about four thousand feet above it, or eight thousand to eighty-five hundred above the sea.

From its crest, this plateau (for the Book Cliffs are but the southern escarpment of a plateau) slopes to the north-northeast at an angle of not more than 5°. It extends from the Wahsatch Mountains on the west, to the foot-hills of the Park Range on the east, and presents everywhere the same characteristics. The Green River crosses it, flowing in a direction exactly the reverse of the dip. It borders the Grand on the north for one hundred and fifty miles, the crest forming the divide between the Grand and the White. On the south side of the crest are broken cliffs; on the north side, the branches of the White River immediately form cañons. This leaves the divide in many places very narrow, in some cases not more than thirty to forty feet wide, with a vertical descent on the south towards the Grand River and an extremely steep earth slope (35° in many cases) at the heads of the streams flowing north to the White River. This crest, though not over eighty-five hundred feet in height, is the highest land for a long distance in every direction.

After leaving the Uncompahgre agency, the party followed Gunnison's Salt Lake road to the Grand and down that river to the mouth of the Dolores, in latitude 38° 50′, longitude 109° 16′. At this point they turned northward and went up to the crest of the Book plateau. They followed this crest to the eastward for upwards of a hundred miles to longitude 108° 15′, then descended to the Grand and followed it up to longitude 107° 35′, and thence went, via the White River (Ute) Indian agency, to Rawlins, where they arrived on October 23d.

The whole area worked is about thirty-five hundred square miles, in surveying which about sixty stations were made. The geological work of this division by Dr. Peale connects directly with that done by him in 1874 and 1875. Sedimentary formations prevail in both districts visited during the past season.

The country first examined lies between the San Miguel and Dolores rivers, extending northward and northwestward from Lone Cone Mountain. The general character of this region is that of a plateau cut by deep gorges or cañons, some of which, especially towards the north, extend from the sandstones of the Dakota Group to the top of the red beds. The depth of the cañons, however, is no indication of their importance as stream beds, for away from the main streams they are dry the greater portion of the year. There are no great disturbances of the strata, what folds do occur, being broad and comparatively gentle.

The San Miguel River, leaving the San Juan Mountains, flows towards the northwest and with its tributaries cuts through the sandstones of the Dakota Group, exposing the variegated beds lying beneath, that have generally been referred to the Jurassic.

About twenty-five or thirty miles north of Lone Cone, the river turns abruptly to the west and flows west and southwest for about fifteen miles, when it again turns and flows generally northwest until it joins the Dolores. Between the San Miguel and Lone Cone the sandstones of the Dakota Group or number one Cretaceous are nearly horizontal, forming a plateau which on approaching the mountains has a capping of Cretaceous shales.

Beyond the bend, the San Miguel flows in a monoclinal valley in which the cañon walls are of the same description as in the upper part of its course. As the mouth is approached the red beds appear. Between this portion of the course of the San Miguel and the almost parallel course of the Dolores, which is in a similar monoclinal rift, there are two anticlinal and two synclinal valleys parallel to each other. They are all occupied by branches of the Dolores. Lower Cretaceous Jurassic and Triassic strata outcrop and present some interesting geological details which will be fully considered in the report on the district. The Dolores River comes from a high plateau in a zigzag course, flowing sometimes with the strike and sometimes with the dip of the strata. Its general course on the western line is about northwest, from which it turns to the northward and westward, finally changing to northwest again for its junction with the Grand. It is in a cañon the greater part of its course.

In the region of country north of Grand River, the geological formations extend uninterruptedly from the red beds exposed on Grand River to the white Tertiary cliffs forming the summit of the "Roan Mountains" or Book Cliffs. The Grand is generally in a cañon in the red beds.

On the north side, the number one Cretaceous sandstone forms a hog-back sloping towards the cliffs. Between the crest of this hog-back and the cliffs, there is a broad valley formed by the erosion of the soft Cretaceous shales which extend to the base of the cliffs and in some places form their lower portion.

The cliffs are composed mainly of Cretaceous beds, rising one above another in steps, until an elevation of about eight thousand feet is reached. The summit is the edge of a plateau sloping to north-northeast. This plateau is cut by the drainage flowing into the White River from the south. These streams rarely cut through the Tertiary series.

Coal of poor quality is found in the sandstones of the Dakota Group and also in the sandstones above the middle Cretaceous beds. Wherever noticed it was in thin seams and of little economic importance.

The White River division was directed by G. B. Chittenden as topographer, accompanied by Dr. F. M. Endlich as geologist. The district assigned to this party as their field for exploration during the season of 1876 commenced from the eastward at longitude 107° 30′, joining on to the work previously done, and extended westward thirty miles into Utah Territory. Its southern boundary was north latitude 39° 30′, while the White River formed the northern limit. In order to complete the work to the greatest possible advantage in the shortest time that could be allowed, it was determined to make the White River agency the headquarters, and in two trips from there finish the work. About thirty-eight thousand square miles comprised the area surveyed.

In working up the topography of the district, the party spent forty-eight days of absolute field work, made forty-one main topographical stations and sixteen auxiliary ones, and traveled within the district about one thousand miles. The party ascertained the course of all the main trails, the location and quality of all the water, which is scanty throughout, and can map with considerable accuracy the topographical forms and all the watercourses. The area is almost entirely devoid of topographical "points" and the topographer is obliged to depend to a considerable degree on those far to the north and south for the triangulation. The country has been heretofore almost entirely unexplored, and was described by the nearest settlers as a broken cañon country, extremely dry. It was marked on the maps as a high undulating plateau, with fresh-water lakes and timber.

The party saw no lakes of more than four hundred yards in diameter and only two or three of those. The country is nearly all inhabitable both winter and summer, and considerable portions of it are valuable, and though three quarters of it is within the Ute Indian Reservation, the advantage of a more accurate knowledge of its character can readily be seen.

While working in the low broken country of Southwestern Colorado last year, Mr. Chittenden made use of a light portable plane table and found it of great value. It appeared at that time that its value was greatest in that class of country, and that in a low rolling district with few prominent points, or in a high-mountain country, it would probably be of little or no use.

Altitudes were determined by the mercurial barometer with a base at the White River Indian agency and checked by a continuous system of vertical angles. The altitude of the agency has been determined by a series of barometric observations extending over two years and a half and referred to railroad levels, and can probably be depended on to within a few feet. The altitude of the agency being about sixty-five hundred feet, and the altitudes in the district ranging from five thousand to eight thousand feet, makes its location the best possible in height for a barometric survey of the region.

It is the intention of the survey during the coming year to publish some tabulated results of the barometric work in Colorado, showing the system and its accuracy and reliability. This may be of use in future work, since the topography of the whole West must greatly depend on barometric determinations of altitude, while Colorado has furnished almost every possible phase of western topography.

The longest dimension of the work lying east and west and the White and Grand rivers running in approximately parallel courses, the district stretched from the White River up over the divide between the Grand and White and embraced the heads of the lateral drainage of the former river.

The general topography is a gentle rise from the White River towards the south, and a sudden breaking off when the divide is reached into rugged and often impassable cliffs known on the maps as the Roan or Book Mountains. The gentle plateau slope of the White River side is cut by almost numberless and often deep cañons, and in many cases the surface of the country has been eroded, leaving broken and picturesque forms, the lower benches generally covered with cedars and piñons, and the upper rich in grass.

There are four main streams draining into the White River within the limits of our work, a distance of something over one hundred miles.

The country is almost entirely destitute of timber and has but little good water. It is, however, abundantly and richly supplied with grass, and, especially in the winter season, must be well stocked with game. It seems well adapted to its present use as an Indian reservation, and is likely to remain for years to come more valuable for them than it could be for settlement.

In the far western portion, and outside the limits of the reservation, one large vein of asphaltum and several small ones were found, and also running springs of the same material, all of which if once reached by railroads will prove of great commercial value. These deposits have been spoken of before, but their location has not been accurately determined. The principal vein seen by this party is at present about one hundred miles from railroad communication, but less than half that distance from white settlements, and is likely in the present rapid growth of the country to be within a few years made available.

According to the report of F. M. Endlich, the geology of the district is very simple, though interesting. Inasmuch as there is but one divide of importance within the district, the work was somewhat simplified. This divide is formed by the Book Cliffs and separates the drainages of the Grand on the south from that of the White on the north. Both of these rivers flow a little south of west into the Green River, which they join in Utah. From the junction of the Grand and Green downward, the river is called the Colorado. Orographically the region surveyed is comparatively simple. The Book Cliffs are the summit of a plateau, about eight thousand feet above sea-level, which continues unbroken over to the Green River. Towards the south these cliffs fall off very steeply, forming deep cañons that contain tributaries of the Grand River. On the north side, with the dip of the strata the slope is more gentle, although in consequence of erosion numerous precipitous cliffs are found. Descending in that direction the character of the country changes. Instead of an unbroken slope, we find that the plateau has been cut parallel by the White River drainage and the long characteristic mesas of that region testify to the action of erosion. Approaching the river, constantly descending with the slight dip of the strata, the bluffs become lower and lower. Though the creek valleys are wide and at certain seasons no doubt well watered, the vegetation is

that of an arid country. Dwarf pines, piñons, and sage-brush abound, to the almost entire exclusion of other trees or grass. Traveling down White River this character is again found to change. A new series of bluffs, occasioned by heavy superincumbent strata, gives rise to the formations of deep cañons. For forty-five miles the party followed the cañon of the White, which no doubt is analogous to that of the Green, and probably closely resembles that of the Colorado in its detail features. Vertical walls enclose the narrow river-bottoms and the slopes of the higher portions are ornamented by thousands of curiously eroded rocks. Monuments of all kinds and figures that can be readily compared to those of animated beings enliven the scenery, which otherwise would be very monotonous. Two thousand to three thousand feet may be stated as the height of the walls inclosing the White River. Geologically speaking, the district is one of singular uniformity. Traveling westward, the older formations, reaching back as far as the Triassic, were found. This is followed by Cretaceous, which in turn is covered by Tertiary. About three quarters of the region surveyed was found to contain beds belonging to this period. Owing to the lithographical character of the strata, water was a rare luxury in this region, and men and animals were frequently compelled to look for springs. Farther west still, the Green River Group sets in, forming those numerous cañons of which that of the White River is one.

Having completed their work by October 14th, the party marched eastward through Middle Park, and after twelve days of rain and snow reached Boulder City, Colorado.

The field work of the Yampah division during the past season was principally confined to a district of Northwestern Colorado lying between the Yampah and White rivers, and between Green River and the subordinate range of mountains that lies west of and parallel with the Park Range. The area is embraced between parallels 39° 30′ and 40° 30′ and meridians 107° 30′ and 109° 30′.

The party consisted of Mr. G. R. Bechler, topographer directing, accompanied by Dr. C. A. White, the well-known geologist. They proceeded southward from Rawlins Springs, a station on the Union Pacific Railroad, on August 6th, toward their field of labor. From Rawlins Springs to Snake River, a distance of eighty miles, table-lands form the chief feature of the topography, while from Snake River to the Yampah River the surface is

more undulating and thickly covered with sage. Between the Yampah and White rivers, a distance of fifty miles, the country is mountainous; and on the divide between the Yampah and White rivers the elevation is eight thousand to nine thousand feet. Mr. Bechler, after having formed the geodetic connection with the work of previous years, concluded to finish the more mountainous portion of the area assigned to him, which began in the longitude of the White River agency and extended westward to about 108° 10′. Here the party found water and grass in abundance, with one exception.

The plateau country, however, was so destitute of water and so cut up with dry gorges or cañons with scarcely any grass or timber of any kind, that traveling was rendered very difficult. The party therefore made White River its base of supply for water and grass, making side trips among the barren hill-tops or plateaus in every direction.

From the Ute Agency, which is located approximately in latitude 38° 58′ and longitude 107° 48′, the White River takes an almost due west course for fifteen or eighteen miles, most of the way through an open valley with here and there narrow gorges. About fifty miles from the agency, the river opens into a broad barren valley, with only here and there scanty patches of vegetation. Soon after, the river enters a deep cañon with vertical walls one thousand feet or more in height which continue to increase in depth until the river flows into the Green River.

The Yampah or Bear River occasionally deviates from a westerly course only for a few miles. Like White River it flows through a plateau country which rises gently from the river, back for a distance of about eight miles. South of the river lie the Williams River Mountains, which have a gradual slope to the north. Williams Fork, flowing from a southeastern direction, joins the Yampah River. West of the junction, the Yampah traverses the country more or less in a cañon, occasionally emerging into an open grassy valley, then enters a deep cañon, cuts through the Yampah Mountains, when it joins with the Snake River. The place of junction resembles a fine park surrounded on all sides with eroded terraces and plateau spurs, that rise by steps to the divide on either side. This park is about eight miles in length from east to west.

After leaving this park the river enters a huge fissure in the mountains, where it remains until, completing its zigzag course, it joins the Green River in longitude 109° 40′ and latitude 32° 00′.

After the junction with the Yampah, the Green River continues in a cañon for fourteen miles where it passes through the picturesque palisades of Split Mountain into an open broad valley, longitude 109° 15′, latitude 40° 28′, from which point it takes a southeast direction through the Wamsitta Valley, where it unites with the White River.

Into both White and Yampah rivers, numerous branches extend from either side, forming deep cañons the greater portion of their length. We may say in brief, that the sides of the valleys expand and contract, at one time forming the beautiful grassy valleys which in olden times were celebrated as the favorite wintering places for the trappers, or contracting so as to form narrow cañons or gorges with walls of varied height.

The walls of Yampah Cañon average about one thousand feet, while the mountains receding back to the northward attain an elevation of forty-two hundred feet, and the highest point of the plateau on the south side is thirty-four hundred feet above the river level.

Of the plateaus between White and Yampah rivers, Yampah Plateau is the largest, and occupies an area of four hundred square miles. The surface of the summit is undulating and on the south side it presents a steep face, several hundred feet in height, covered with débris, rendering it almost inaccessible. This plateau is covered with excellent grass and gives origin to numerous springs, all of which dry up within a short distance of their source. As a whole, this district is very arid, barren, and almost entirely destitute of tree vegetation.

The total number of stations made by Mr. Bechler in the district assigned to him was forty, and the entire area about three thousand square miles. Barometric observations were made whenever needed, and about two thousand angles of elevation and depression with fore and back sights, so that the material for attaining the correct altitudes is abundant.

The rocks of this district embrace all the sedimentary formations yet recognized by the investigators who have studied the region that lies between the Park Range and the Great Salt Lake, namely, from the Weber Quartzite (which underlies the Carboniferous) to the group or latest Tertiary, inclusive. Not only has the geographical distribution of these formations been mapped, but all the displacements of the strata have been traced and delineated. The last-named investigations bring out some interesting and important facts in relation to the orographic geology of the region, especially as regards the eastern termina-

tion of the great Uinta uplift and the blending of its vanishing primary and accessary displacements with those of the north and south range above-mentioned. Much information was also obtained concerning the distribution of the local drift of that region, the extent and geological date of outflows of trap, etc.

The brackish water beds at the base of the Tertiary series, containing the characteristic fossils, were discovered in the valley of the Yampah. They are thus shown to be exactly equivalent with those, now so well known, in the valley of Bitter Creek, Wyoming Territory. These last-named localities were also visited at the close of the season's work, and from the strata of this horizon at Black Butt's Station three new species of *Unio* were obtained, making six clearly distinct species in all, that have been obtained, associated together in one stratum, at that locality. They are all of either distinctively American types or closely related to species now living in American fresh waters. They represent, by their affinities, the following living species: *Unio clavus* Lamarck; *U. securis* Lea; *U. gibbosus* Barnes; *U. metanurus* Rafinesque and *U. complanatus* Solander. They are associated in the same stratum with species of the genera *Corbula*, *Corbicula*, *Neritina*, *Viparus*, etc., this stratum alternating with layers containing *Ostrea* and *Anomia*.

The close affinity of these fossil Unios with species now living in the Mississippi River and its tributaries seems plainly suggestive of the fact that they represent the ancestry of the living ones. An interesting series of facts has also been collected, showing that some of the so-called American types of Unio were introduced in what is now the great Rocky Mountain region, as early as the Jurassic period, and that their differentiation had become great and clearly defined as early as late Cretaceous and early Tertiary times. Other observations suggest the probable lines of geographical distribution, during the late geological periods, of their evolutional descent, by one or more of which they have probably reached the Mississippi River system and culminated in the numerous and diverse forms that now exist there.

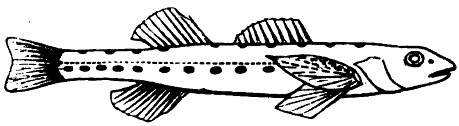
The work of the past season shows very clearly the harmonious relations of the various groups of strata over vast areas; that although there may be a thickening or a thinning out of beds at different points they can all be correlated from the Missouri River to the Sierra Nevada Basin. The fact also that there is no physical or palæontological break in these groups over large areas from the Cretaceous to the Middle Tertiary is fully established. The transition from marine to brackish-water forms

of life commences at the close of the Cretaceous epoch and without any line of separation that can yet be detected continues on upward until only purely fresh-water forms are to be found. Dr. White, an eminent palæontologist and geologist, says that the line must be drawn somewhere between the Cretaceous and Tertiary epochs, but that it will be strictly arbitrary, as there is no well marked physical break to the summit of the Bridger Group.

THE SAND DARTER.

BY D. S. JORDAN AND H. E. COPELAND.

WE have often brought home with us a "Johnny," "Speck," or "Crawl-a-bottom," of a different type from any of those whose habits we already knew.[1] It had a very sharp nose that



(FIG. 4.) THE SAND DARTER.

projected over its mouth; its body was exceedingly slim and round, as transparent as jelly, but firm and wiry to the touch. Its belly and much of its back, after a fashion peculiar to itself, were quite bare of scales, and those along the sides were small and inconspicuous. These peculiarities seemed the more striking as the other darters are scaly, and, along the middle line of the belly especially, they are often covered with hard plates, an arrangement obviously adapted to their "crawl-a-bottom" habits.

After much searching through the scattered and unsatisfactory descriptions which eastern naturalists have given us of the darters found in their bottles of alcohol, we decided that our little friend was the "pellucid darter," or better, the "sand darter" (*Pleurolepis pellucidus*[2] Agassiz), for reasons soon to be given.

[1] American Naturalist, June, 1876. Page 335.

[2] As this species is quite imperfectly known to naturalists, we here subjoin its synonymy and a description taken from the average of numerous specimens.

"*Etheostoma pellucidum* Baird MSS., 1853."

Pleurolepis pellucidus Agassiz in Putnam's Bulletin Mus. Comp. Zoöl., 1863, 5. Cope, Cyprinidæ of Penn., Supplement, 1866, 401. Le Vaillant, Recherches sur les Poissons, etc., 1874 Jordan, Indiana Geol. Survey, 1874, 214. Manual Vertebrates, 1876, 221. Jordan and Copeland, Check-List, Bull. Buffalo Soc. Nat. Hist., 1876, 135. Nelson, Bull. Ills. Mus. of Nat. Hist., Dec., 1876, p. 35. Jordan and Gilbert, Fishes of Indiana, Indiana Farmer for Jan. 17, 1877.

Our aquarium had been arranged for the convenience of our old etheostomoid friends, and the bottom was thickly covered with stones, among which a small fish might easily hide. Several days passed after the introduction of the first *Pleurolepis* that survived the change of water, when it was noticed that it had disappeared. Careful search among the stones and around the geode only made it the more certain that it had gone, and increased our wonder as to the way, for surely it had not been eaten, nor had it jumped out, unless like Ariel it could assume a "shape invisible." Finally, after retracing every inch of the ground, there was discovered under the nose of Boleosoma, which was standing as usual on its hands and tail, the upper edge of a caudal fin, and on each side of Boly's tail appeared a little black eye set in a yellow frame. Pleurolepis was buried! Was he dead? Slowly one eye was closed in a darter's inimitable way, for they can outwink all animals in creation except owls, and the touch of a finger on its tail showed that it had lost none of its activity. It was quite improbable that it had been accidentally buried so completely, a small spot, therefore, was cleared of stones, leaving the hard white sand exposed, and we awaited developments.

There for days we watched it closely, only to learn that it could bury itself with great celerity, for it was never caught in the act. Our patience was at last rewarded, however, for as we came out to breakfast one morning it put its nose, that we now

Generic Characters. Body nearly cylindrical, very slender, the depth being contained six to eight times in the length of the body, to base of the caudal; the breadth of the body about the same as the depth; head long, pointed, the upper jaw longest; lateral line very distinct, complete; scales thin, small, punctate, especially above, with fine black dots, far apart and deeply imbedded, obscure on the back, but generally present; wanting on the belly, readily evident only along the lateral line and on the opercles; fins rather low (as compared with other darters), the dorsal fins well separated; anal spines two; intermaxillaries projectile, the skin of the upper lip not continuous with that of the forehead; teeth minute, on jaws and vomer; mouth comparatively wide, much as in *Etheostoma*; branchiostegals six, their membrane broadly connected across isthmus.

Specific Characters. Head four to four and half in length of body, without caudal; eye large, rather high up, its diameter a trifle less than length of snout, forming about one fourth of the length of the head; iris gilt. Body pinkish-white, or faintly olivaceous, perfectly pellucid in life; a series of small squarish olive blotches, lustrous steel blue in life, along the back and another on each side, these connected by a gilt line. Fin rays: D. x. 9; A. ii. 8; first dorsal longer and lower than second, which is smaller than the anal fin. Length two to three inches.

Habitat. Ohio Valley, Youghiogheny R. (Cope), Eastern Ohio (Dr. Kirtland's Coll.), White R., Ind. (Jordan and Copeland), frequenting sandy bottoms of clear streams.

Pœcilichthys vitreus, Cope (Proc. Am. Phil. Soc., 1870, p. 263), probably belongs to this genus.

know has a tip nearly as hard as horn, against the bottom, stood nearly straight on its head, and with a swift beating of its tail to the right and left was in less than five seconds completely buried. The sand had been violently stirred, of course, and just as it had nearly settled, probably in less than half a minute, its nose was pushed quietly out and, settling back, left the twinkling eyes and narrow forehead alone visible.

Since then we have kept scores of them in an aquarium arranged especially for their convenience, and have often seen them burrow into the sand. They will remain buried as long as the water is pure and cool, and indeed we now rely nearly altogether upon them to warn us when the water needs changing. They then come out and lie on the bottom, panting violently. We have been unable to discover any immediate incentive for the act. It seems to be entirely unpremeditated. A number of them in confinement lie helplessly on the bottom, motionless and slowly breathing, when one suddenly starts and buries its head and neck in the now whirling sand by a motion as quick as thought, a headless tail beats frantically about, and when the clean sand lies smoothly on the bottom again the little eyes are looking at you like two glistening beads, as if to witness your applause at so clever a trick.[1]

We never have seen a Pleurolepis taste of food, nor do we expect to, for although its mouth bristles with teeth its small size forbids an attack on any game which we can offer. Its quiescent habits, and the character of the bottoms to which it confines itself, seem to indicate that its prey is minute if not microscopic. But speculation about what we don't know as to its food might lead us to speculation as to the mode of evolution of its characteristic features; how, for instance, the hard snout and the burrowing habits are consequent upon the loss of scales, or how the loss of unnecessary scales are consequent on its burrowing habits, matters not within the defined scope of this article.

Specimens of this species may be readily obtained in regions where it occurs. We have taken at one drawing of a fine-meshed minnow net, no less than twenty-four individuals over a sandbar in White River, above Indianapolis, where the usual depth of the water is about two feet.

[1] Since this article was written, a small Boleosoma (*B. brevipinne* Cope), in Professor Copeland's aquarium has been noticed to bury himself in the sand as persistently as the Pleurolepis does, and in similar fashion. In no other individual of this species, and in no other species excepting the "Sand Darter," have we noticed this habit, although during the last two years we have had hundreds of individuals under examination. — D. S. J.

OBSERVATIONS UPON THE DISTRIBUTION OF PLANTS IN NEW HAMPSHIRE AND VERMONT.[1]

BY WILLIAM F. FLINT.

EVERY one who has botanized must have observed that many of the species common in one part of the country are elsewhere replaced by different ones. We are often surprised to learn that our neighboring botanists find species with which we are most familiar to be only local or altogether wanting in their vicinity.

I have been able to learn of but few attempts to find out the manner in which our New England flora is distributed, or to ascertain the causes which have placed our plants as we find them now.

I do not claim to point out many of the latter, but hope that a few facts as to the manner in which some of the plants in the Connecticut Valley, and elsewhere in New Hampshire and Vermont, are found to be distributed, may not prove wholly uninteresting. I shall not attempt to classify them in the same order as we find them arranged in the manuals, but present them, as nearly as possible, as they would be seen to occur by an observer in journeying from the sources of the rivers toward the sea.

The most important, probably, of the causes which limit the range of different genera and species of plants is that of *altitude*, or the height of the land above the sea-level, as this serves to produce the same differences in the temperature over a small extent of country, which change in latitude does over a larger one.

The flora of Northern New England presents two well-marked divisions, depending mainly upon the different temperature caused by this difference in elevation, which have been termed the Alleghanian and the Canadian. The former is represented by forests composed of chestnut, oak, pitch and red pine, and the latter where spruce, fir, arbor vitæ, and beech predominate.

It is not possible to draw a definite line for the meeting of these two floral districts, because differences of soil and the power which plants have of adapting themselves in some degree to climatic changes bring about a meeting ground of varying width between them.

Were one at the sources of the Connecticut, he could not fail to remark the very different appearance of the flora from that of

[1] A paper read before the meeting of the Connecticut Valley Botanical Society, held at Hanover, N. H., June 6, 1876.

Massachusetts. Here, black spruce (*Abies nigra*), white spruce (*A. alba*), and arbor vitæ (*Thuja occidentalis*), take the place of the oaks, hickories, and pitch pines of this river further south. These, together with the beech (*Fagus ferruginea*), sugar-maple (*Acer saccharinum*), the canoe and yellow birch (*Betula papyracea* and *B. lutea*), constitute the greater part of the forest and present a good type of the Canadian wilderness.

Here, also, Labrador tea (*Ledum latifolium*) and the Canada blue-berry are the representatives of the multitude of ericaceous shrubs found further south. The high cranberry tree (*Viburnum Opulus*) may be found throughout the valley, but in this region it finds its proper home, occurring in abundance along the streams. With it is the hoary willow (*Salix candida*), which, as it is common throughout Northern New Hampshire and Vermont, and extends into Maine, may be considered as a strictly Canadian species.

Two or three species of *Glyceria*, blue-joint grass (*Calamagrostis Canadensis*), timothy (*Phleum pratense*), and redtop (*Agrostis vulgaris*), represent the greater part of the grass family (*Gramineæ*) belonging to this region. The ponds and slow streams are more likely to contain the variety *pumilum* of the yellow water-lily (*Nuphar advena*) than the typical form.

Going southward, we find that the white spruce (*Abies alba*) disappears from the New Hampshire side of the river at North Stratford; but, singularly enough, it is still found along the Vermont side as far as to the mouth of the Passumpsic River.

At Dalton, N. H., near the head of Fifteen Miles Falls, the hoary willow (*Salix candida*) disappears. The purple meadow-rue, which seems to have a truly Canadian habitat, continues common throughout the length of this long rapid, and is last seen at the Nine Islands near the mouth of the Passumpsic.

The Canadian character of the flora predominates nearly to the foot of these falls, or to within six hundred feet of the sea-level. Here are to be found maiden-hair (*Adiantum pedatum*), *Orchis spectablis*, sweet-fern (*Comptonia asplenifolia*), frost grape (*Vitis cordifolia*), and sheep-laurel (*Kalmia angustifolia*), forming the first group of strictly Alleghanian species.

As these plants are found in other parts of New Hampshire to have this altitude above the sea at their northern limit, the contour line of six hundred feet can be taken for our purpose, as the dividing line between the two districts.

But there is no disappearance of Canadian species until we

reach the mouth of the Lower Ammonoosuc and Wells rivers. There the Labrador tea (*Ledum latifolium*) is altogether wanting, and the arbor vitæ and high cranberry tree become much less numerous.

The forests which cover the high terraces at the mouth of these rivers are composed of pitch and red pines (*Pinus rigida* and *P. resinosa*) and white oaks (*Quercus alba*).

Mountain rice grasses (*Oryzopsis Canadensis* and *O. asperifolia*) first appear in these woods, which would indicate that they as well as the trees are Alleghanian. A few miles south of this, at Haverhill, N. H., hackberry (*Celtis occidentalis*) and bitter hickory (*Carya amara*) are added, and below this point the Alleghanian type of vegetation predominates in the immediate vicinity of the river. Arbor vitæ and the mountain alder (*Alnus viridis*) are the only Canadian species present, and these find their southern limit at the White River Narrows between Hanover and White River Junction.

Azalea nudiflora is the most noticeable addition before reaching North Charlestown, where we abruptly meet with a group of trees common throughout the valley in Massachusetts. These are chestnut (*Castanea vesca*), yellow oak (*Quercus coccinea*, var. *tinctoria*), shell-bark hickory (*Carya alba*), button-wood (*Platanus occidentalis*), and, growing in their shade, the huckleberry (*Gaylussacia resinosa*) and the rattlesnake weed (*Hieracium venosum*).

Bellows Falls, Vt., seems to be the next place for the appearance of another group, apparently marking the northern limit of dwarf sumac (*Rhus copallina*), shrub oak (*Quercus ilicifolia*), summer grape (*Vitis æstivalis*), liberty tea (*Ceanothus Americanus*), cranesbill (*Geranium maculatum*), *Aster lævis*, *Solidago gigantea*, *Bidens chrysanthemoides*, *Cassia Marilandica*, butterfly weed (*Asclepias tuberosa*), spice bush (*Lindera Benzoin*), foxtail grass (*Aleopecurus pratensis* and *A. geniculatus*), *Calystegia spithamæa*, and *Vaccinium vacillans*; quite an array of species which seem to have found these falls an effectual barrier to their march northward.

Along the valley between Bellows Falls and Brattleboro are the high blue-berry (*Vaccinium corymbosum*) and *Andromeda ligustrina*, but it is not quite certain whether or not they should belong with this group.

The cotton-wood (*Populus monilifera*) first appears on an island in the river near the north line of Westmoreland, N. H.,

and is seen very commonly in the immediate vicinity of the river as far south, at least, as the Massachusetts line. Spoon-wood (*Kalmia latifolia*) and gray birch (*Betula alba*, var. *populifolia*) find their northern limit in this town at a point opposite Dummerston, Vt. South of Brattleboro, deer grass (*Rhexia Virginica*), false fox-glove (*Gerardia flava*) and at the mouth of the Ashuelot River in Hinsdale, N. H., *Cornus paniculata* and *Alnus serrulata*, are the principal additions before reaching Massachusetts.

Beside these there are others, and they would probably make up a much larger list, which are probably never found at these northern limits growing at an altitude much above that of six hundred feet above the sea, but for which I have not been able to gather sufficient data to warrant making the same approximation.

I will mention the northern limit at which I have observed a few of them: moon-seed (*Menispermum Canadense*), ground-nut (*Apios tuberosa*), near Windsor, Vt.; *Desmodium Canadense* and *Betula lenta* at South Charlestown, N. H.; *Prunus pumila*, islands of the river near Quechee Falls in Plainfield, N. H.; *Aster undulatus* and water-plantain (*Alisma Plantago*) at Hanover; *Viola sagittata* and river beech (*Carpinus Americana*) at Haverhill, N. H. *Calystegia sepium* and Virginia creeper (*Ampelopsis quinquefolia*) occur as far north as Lancaster, N. H., but are probably Alleghanian species which have been hardy enough to extend thus far northwards in spite of the increased severity of the climate.

The coltsfoot (*Tussilago Farfara*), if an introduced plant, must have entered the Connecticut Valley by the way of Canada, and seems to find the soil and climate north of Dalton best adapted for its growth, being abundant on the high clay banks of the river and along the mountain tributaries, but occurring much more rarely below the altitude of six hundred feet.

The distribution of the different species of grapes belonging to this valley is somewhat interesting. *Vitis cordifolia* is the hardiest, extending as far north as the foot of Fifteen Miles Falls. The summer grape (*Vitis æstivalis*) has not established itself north of Bellows Falls. I have been unable to find that the fox-grape (*Vitis Labrusca*) is indigenous anywhere in this valley, north of Massachusetts; but it is common along Miller's River and its tributaries in that State, which would indicate that the northern point for this species is near its mouth.

A few species seem to have found the valley of the Ashuelot River better suited to their growth than the main river valley north of its mouth. We find the flowering dogwood (*Cornus florida*) at Hinsdale; *Sagina procumbens*, *Cyperus filiculmis*, and *C. strigosus*, common along the plains of Keene and Swansey; and in the swamps, *Symplocarpus fœtidus*, which attains a greater range than the others, having established itself in the bogs around the base of Monadnock.

In the Merrimack Valley and that part of New Hampshire east of it, Canadian plants are fewer in numbers, both of species and individuals, than in the same latitude of the Connecticut Valley. Also, owing probably to the greater distance from the high lands, and to being much nearer the ocean, we find many Alleghanian species which do not extend in the Connecticut Valley farther north than Central Massachusetts.

It is somewhat surprising to any one familiar with that part of New Hampshire occupied by the Connecticut and its tributaries, to find the district belonging to the Merrimack the richest floral region in the State, and this, too, notwithstanding that the soil is not nearly so fertile. But it only proves that the warmer temperature of Eastern New Hampshire is more than enough to compensate for any decrease in the number of species that might be brought about by a less fertile soil.

We here find that the species traced throughout the former region do not seem to arrange themselves in groups with wide intervals between them, nor do their limits always appear in the same order.

In the Pemigewasset valley the frost grape first appears near the mouth of the East Branch, but nothing is seen of sheep laurel (*Kalmia angustifolia*) and sweet-fern (*Comptonia asplenifolia*) until near Plymouth, twenty miles further south. Arbor vitæ (*Thuja occidentalis*) stops near the south line of Thornton, but its companion, *Alnus viridis*, continues somewhat common to where the junction of the Pemigewasset and Winnipesaukee rivers forms the Merrimack.

A short distance south of the mouth of the East Branch, near the south line of Campton, *Pinus rigida*, *P. resinosa*, and gray birch (*Betula alba*, var. *populifolia*), make their appearance, and the white oak (*Quercus alba*) before reaching Plymouth, but the chestnut is wholly wanting north of the mouth of Smith's River, a short distance below Bristol. *Rhus copallina* is abundant at Livermore's Falls, just north of Plymouth. *Vaccinium vacillans*

and *Quercus ilicifolia* have their northern limit at Boscawen, shell-bark hickory and huckleberry at the mouth of Winnipesaukee River, while buttonwood (*Platanus occidentalis*) is found along the banks of the Pemigewasset, nearly to Plymouth. Mountain laurel (*Kalmia latifolia*) extends north to Concord, and *Asclepias tuberosa* to Thornton's Ferry.

From Concord to Nashua, we find near the river the following species, which appear to be wanting in that part of the Connecticut Valley belonging to New Hampshire. Commencing at Concord we find red ash (*Fraxinus pubescens*), *Clethra alnifolia*, *Scirpus sylvatica*, and *S. microcarpa*. The sand hills at Hooksett are sprinkled with bird's-foot violet (*Viola pedata*). The plains opposite Amoskeag Falls support a dwarf oak (*Quercus prinus*, var. *humilis*), which continues to be abundant, forming along with *Quercus ilicifolia* the shrub-oak thickets so common to these sand plains. Here, also, the bear-berry (*Arctostaphylos Uva-ursi*), generally supposed to be a highland species, occurs in greater abundance than elsewhere in the State.

Some of the swamps in this vicinity are filled with *Cupressus thyoides*, the white cedar of all the coast towns of Massachusetts. Another tree common to the borders of these cedar swamps in the same localities, the swamp white oak (*Quercus bicolor*), appears at the mouth of the Souhegan River, and *Salix tristis* is the common willow of the dry plains in this vicinity. Near Nashua we have *Aster patens*, blazing star (*Liatris scariosa*), sea sand-reed (*Calamagrostis arenaria*), prickly ash (*Zanthoxylum Americanum*), and in the adjoining town of Hudson the climbing fern (*Lygodium palmatum*). *Struthiopteris Germanica*, the ostrich fern, seems to be properly a Canadian species, not occurring south of Concord in this valley.

We find the water-shed between the Merrimack and Connecticut to have a predominant Canadian flora as far south as the latitude of Bellows Falls. Below this point the Alleghanian plants have found the temperature such as to allow them to attain to higher elevations, and to mingle with the northern types, and the strictly Canadian forest is limited to the cold swamps and summits of the highest hills.

From the data which I have been able to collect concerning Vermont, it appears that the greater portion of the State is occupied by the Canadian flora, and that the area occupied by white and black spruce and arbor vitæ is considerably greater than that occupied by the same trees in New Hampshire; the Alleghanian

area, aside from that of the Connecticut Valley, being included in a narrow belt extending the entire length of the State west of the Green Mountains. Throughout its extent white oak, bitter hickory, pitch and red pine, sweet-fern and frost grape are common, mingling at the northern end of Lake Champlain with the Canadian arbor vitæ and white spruce. The chestnut, buttonwood and mountain laurel probably do not exist much north of Burlington.

The following species which are to be met with in New York and further westward do not appear to be found east of the Connecticut Valley, and most of them are confined to the immediate vicinity of the river: *Carya amara*, *Celtis occidentalis*, *Populus monilifera*, *Salix longifolia*, and *Salix livida*, var. *occidentalis;* the last one of these having the widest distribution being found throughout the entire valley, but apparently not passing over the water-shed into the Merrimack district. The hairy-leaved white violet (*Viola renifolia*, Gray; n. sp.) is to be met with between the mouth of the Passumpsic and Plainfield, N. H.

The following may be called rare, having but a single locality for each: *Lobelia Kalmii*, ledges at the foot of Fifteen Miles Falls; *Cypripedium pubescens*, at Hanover; *Arabis Drummondii*, on an island in the river just south of White River Junction; and *Astragalus Robbinsii*, rocks at Quechee Falls, Plainfield, N. H.

THE SUESSONIAN FAUNA IN NORTH AMERICA.

BY PROF. E. D. COPE.

IN a paper read before the National Academy of Sciences at the spring session of 1876 in Washington, the writer announced the identification of the Wahsatch Eocene formation of New Mexico with the Suessonian or Lower Eocene of France and England. The beds, which were explored while connected with the United States Geographical and Geological Survey, west of the one hundredth meridian, in charge of Lieut. G. M. Wheeler, in 1874, were found to contain the remains of a fauna, almost identical with that of the European beds in question. This was thought to be an important accession to American geology, as furnishing a basis for an estimation of the relative ages of the ormations immediately above and below the Wahsatch horizon. The parallelism of the fauna includes the genera of reptiles, birds,

and mammals, and among the latter, of the types both of carnivorous and of hoofed quadrupeds. Gar-fishes (*Lepidosteus*) appear in both countries, and the predominant mammalian genera of both are *Coryphodon* and *Hyracotherium*. Gigantic birds inhabited the land; in New Mexico they belonged to the genus *Diatryma*, and in France to *Gastornis*. The New Mexican genus *Ambloctonus* represents the carnivorous *Palæonyctis gigantea* of the lignites of Soissons. The only marked difference between the faunas which the then state of discovery disclosed is the existence of the order *Tæniodonta* in New Mexico, a type presenting characters of the *Edentata*, *Rodentia*, and *Creodonta*, which had not yet been found elsewhere.[1]

The characters of the mammalian fauna are very peculiar, displaying inferiority in many respects. Thus, among the flesh-eaters the brain of the *Oxyæna* is of reduced size, the hemispheres being especially small, while the olfactory lobes are very large and uncovered; and other Creodont genera present the same character. According to Gervais the genus *Arctocyon*, from the Suessonian, presents the same type of brain. The hoofed type, *Coryphodon*, shows a similar inferiority in the constitution of the brain.

So far as these observations have gone, they coincide with those made eight years ago by Professor Edouard Lartet of Paris. He states[2] that it is the result of a number of investigations undertaken in different horizons of the Tertiary strata, that the more we follow *Mammalia* into the antiquity of geological time, the greater is the reduction of the volume of the brain in comparison with the size of the head and the total dimensions of the body. Cuvier observed the form of the brain of the *Anoplotherium* in a cast of marl which was consolidated within the cavity of a skull of this animal, found in the gypsum of Montmartre. He says[3] "it has little volume, and is flattened horizontally; the hemispheres do not present convolutions, but we find only a shallow longitudinal impression on each. All the laws of analogy authorize us to conclude that our animal was greatly deficient in intelligence." In fact the skull of the *Anoplotherium* is six times as long as the cast of its cerebral hemispheres, and this animal, which in dimensions Cuvier compared to a medium-sized ass, had a brain smaller than that of the existing roebuck.

[1] See American Naturalist, 1876, p. 379.
[2] Comptes rendus, June, 1868.
[3] Ossements fossiles, iii., p. 44.

"I owe to the kindness of Professor Noulet, of Toulouse, the possession of a fossil cranium in which I have found the cast of a brain still more ancient than that of the *Anoplotherium* of Montmartre, since the fragment comes from the Eocene of the *Lophiodon* of Issel. In the brain of this animal (which I call provisionally *Brachyodon eocænus*, on account of the slight elevation of the crowns of the molar teeth), there are no longer any convolutions, but only certain folds irregularly graduated; the olfactory lobes are much prolonged in front, and the cerebellum is entirely separated from the hemispheres. This brain is smaller in all respects, and less complicated in its structure than that of the *Cænotherium* described by Gratiolet; but it must not be forgotten that the latter animal is from a formation much more recent, that is, the inferior Miocene of Allier.

"In proportion as we approach the present period, the differences between the fossil brains and those of living species become less marked, as has also been observed with reference to the elevation of the crowns of the molars. Thus the deer and the antelopes of the Middle Miocene of Sansan present many convolutions, while the cerebellum remains moderately uncovered, and the olfactory lobes are very prominent. In the superior Miocene of Pikermi the brain of the *Hippotherium* (*Hipparion*) shows itself a little less rich in convolutions than that of the existing horse; and in a fragment of a skull of a monkey from the same locality, which I have been permitted to examine in the museum, the cerebellum is less completely covered by the hemispheres, and the median vermis is more prominent than in the living *Semnopitheci* of the types most nearly related to those of Pikermi. But in order to show more clearly this disproportion of the fossil brains in relation to those of living *Mammalia*, it is necessary that comparison should be made between species of the same family, or, better still, of the same genus. It has been possible for me to verify this point by the comparison of two carnivorous animals, the living *Viverra genetta*, and the extinct *V. antiqua* of De Blainville, from the inferior Miocene of Allier. From this it appears, that with a cranium one third longer and one fourth wider than the living *V. genetta*, the fossil *V. antiqua* has not a larger brain, and that this brain, more attenuated in its frontal convolutions, does not extend so far forwards. According to Gratiolet a great development of the olfactory lobes is a character of an inferior type. In fact the more we ascend into palæontological antiquity the more we find that the olfactory

lobes display a great development in comparison with the cerebral hemispheres."

The Wahsatch horizon is lower than the oldest above referred to by Professor Lartet, and it is interesting to observe how his generalization with reference to the characters of the mammalian brain is confirmed. The *Oxyæna forcipata* approaches more nearly to the viverrine type than to any other form of the *Carnivora*, although separated by a wide interval. I have been able to obtain a cast of the superior and anterior portions of its cranial chamber, from which it appears that the brain possessed characters of a much lower type than that observed in the *V. antiqua*. The olfactory lobes are enormously developed, rising higher than the hemispheres, from which they are not only entirely free, but are separated by a constriction of their basal portions. The hemispheres are not wider at the middle than the olfactory lobes, and have therefore elongated proportions. Their superior portion is without convolutions. Although not a marsupial, the general form in *Oxyæna* is more like that of the opossum than that of any other living animal, but is still lower in character. Its inferiority is especially seen in its small size. The mandibular ramus of the *O. forcipata* is about the size of that of the jaguar, but the brain, even with its large olfactory lobes, is only about two thirds as long, and one third as wide.

The ankle-joint presents a great simplicity of structure in most of the Wahsatch mammals, both flesh-eaters and hoofed types. The astragalus is nearly flat, and not like a segment of a pulley as in most existing *Mammalia*, and it therefore permitted but little flexure of the foot on the leg. The only exception to this rule is found in the species of *Hyracotherium* and allies of the order *Perissodactyla*, which number ten species out of a total of fifty-four.

As regards the elbow-joint a similar peculiarity was discovered to exist. In the majority of existing mammals, a ridge or bead divides the two facets of the humerus, which receive the ulna and radius respectively; it is called the intertrochlear ridge. In the ox and horse this ridge is very near the external border of the humerus. In the mammals of the Wahsatch beds this ridge was found to be wanting, excepting in the ten species of *Perissodactyla* above mentioned.

In respect to the teeth, no species presenting the selenodont or double-crescent bearing type had been found. Of the simpler types, where tubercles are united into crests, twelve species out

of fifty-four had been discovered. The teeth of the remaining forty-two species are bunodont or tubercular only, and in most cases simple forms of that type.

Another marked feature of the Suessonian or Wahsatch *Mammalia* is the possession by the greater number of them of five toes on both of the feet. The only probable exceptions to this rule are the ten species of *Perissodactyla* already mentioned, and perhaps a very few others. The genera of later and the present periods with three toes on all the feet, with two functional toes, and one toe, are wanting in this fauna.

It was also asserted that nearly all of the species were plantigrade in their mode of progression, that is, that the soles of the fore and hinder feet were applied to the ground, instead of being obliquely elevated behind, the heel thus appearing to form an angle of the leg, as in most living mammals. It is well known that among recent quadrupeds the *Quadrumana*, Plantigrade *Carnivora*, *Proboscidia*, and some *Rodentia* and *Edentata*, are plantigrade, while the others are digitigrade. The only species of the Wahsatch fauna possibly digitigrade are the species of *Perissodactyla*, already mentioned, although it was stated that the structure in a few of the other genera is yet unknown.

The agreement of clawed and hoofed (unguiculate and ungulate) mammals of this period in the general imperfection of the structure of the brain, of the ankle and elbow-joints, and in the position and number of the toes, was dwelt on as an important fact. It did not however warrant the separation of all the *Mammalia* of the Suessonian as a distinct order, on account of the exceptions pointed out. The clawed types presenting these characters have been since [1] defined as an order, under the name of *Bunotheria*, which it was believed might embrace also the existing *Insectivora* as a suborder. The ungulates of like character have already been erected into a distinct order, the *Amblypoda*, which includes two suborders, the *Pantodonta* and *Dinocerata*. The only mammalian orders of that period still existing are then the *Perissodactyla* and *Rodentia*.

[1] Proceedings Academy, Philadelphia, 1876, page 88

ON THE VITALITY OF CERTAIN LAND MOLLUSKS.

BY ROBERT E. C. STEARNS.

AT a meeting of the California Academy of Sciences I submitted for the inspection of the members a living specimen of *Bulimus pallidior* Sby., one of nine given to me by Professor George Davidson, who collected them at San José del Cabo, Lower California, in March, 1873.

These snails were kept in a box undisturbed until June 23, 1875, when I took them out and, after examination, placed them in a glass jar with some chick-weed and other tender vegetable food and a small quantity of tepid water, so as to make a warm humid atmosphere. This hospitable treatment induced them to "wake up" and move about after their long fast and sleep of two years, two months, and sixteen days. Subsequently all died but the one exhibited, which seems to be in pretty good health, though not very active.

It may be remembered that I gave at a meeting of the Academy in March, 1867, an instance, even more remarkable, of vitality in a snail (*Helix Veatchii*) from Cerros Island, the latter having lived without food from 1859, the year when it was collected, to March, 1865, a period of six years.

The famous specimen in the British Museum, which is cited in the books, *Helix desertorum*, had lived within a few days of four years, fastened to a tablet in one of the cases, when discovered to be alive. *Helix desertorum*, as the specific name implies, is found in arid and sterile areas in the continents of Africa and Asia, and has, as will be perceived, a wide distribution. From the former continent, I have specimens from Egypt, and it also ranges through Arabia in the latter. The *Bulimus* from the mainland of the peninsula of Lower California, and *Helix Veatchii* from Cerros or Cedros Island, off the coast on the ocean side of the same, come from within the same physical environment, being only a comparatively limited distance apart. The *Helix* belongs to an interesting and peculiar group, probably varieties of one species, which includes, at present, the following names: (1) *Helix areolata* Sby., (2) *H. Veatchii* Newc., (3) *H. pandoræ* Fbs., and (4) *H. levis* Pfr. Other forms geographically approximate may hereafter on further investigation be referred to the same lineage. Of the above (1) *H. areolata* was the first described, or I should say that this appears by the date to be the first name bestowed upon any member of the group. This

species has been quoted from Oregon, and (4) *H. levis* from the Columbia River, in both cases erroneously. The figures in Land and Fresh Water Shells of North America,[1] page 177, are too elevated and globose for the typical *areolata*, but the larger figures faithfully represent *H. Veatchii.* Elevation and rotundity are insular characteristics in this group, and *areolata* is somewhat depressed. It is found in comparative abundance on the uplands around Magdalena Bay, which is on the outer or ocean shore of the peninsula, in latitude about 24° 40′ N.

Bulimus pallidior, which is pretty generally distributed through Lower California, from Cape St. Lucas northerly, has also erroneously been credited to San Diego in California proper.

It is arboreal in its habits, at least during the winter season, being found on copaiva trees. It has been said to inhabit South America, which is probably incorrect, and the locality "San Juan" mentioned in Land and Fresh Water Shells, on page 195, where a good figure of this species may be seen, should be *San Juanico*, which is on the east or gulf side of the peninsula, in latitude about 27° N.

The great importance of accuracy in habitat will be at once perceived when I state that there are no less than *three* other localities on the west coast of America, *north* of the place cited, all of which are referred to in various scientific works, which have come under my observation as San Juan, and there are perhaps as many more San Juans, *south* of that especially quoted herein, on the westerly coast of America, in the Central and South American States. Attention is directed to the fact that the three species here mentioned as exhibiting extraordinary vitality belong to geographical areas which receive only a minimum rainfall, or which are, in simple language, nearly rainless regions.

Within such areas vegetation is exceedingly limited even in favorable seasons, and the presence and growth of the annual plants is of course dependent upon the rainfall; this last occurring infrequently makes the food supply of land mollusks and other phytophagous or vegetable-eating animals exceedingly precarious.

It is highly probable that a careful investigation in this direction will lead us to the conclusion that the land mollusks which inhabit these arid areas have, through selection, adaptation, and evolution, become especially fitted for the contingencies of their

[1] Smithsonian Misc. Coll., No. 194.

habitat, and possess a greater degree of vitality or ability to live without food than related forms in what may be considered more favorable regions, and through and by reason of their long sleep or hibernation (more properly æstivation), with its inactivity and consequent immunity from any waste or exhaustion of vital strength, are enabled to maintain their hold upon life when animals more highly organized would inevitably perish; and we are furnished with an illustration in the instances cited, how nature works compensatively, when we institute a comparison with the opposite condition of activity, and the food required to sustain it.

BARNACLES.

BY J. S. KINGSLEY.

QUAINT old Gerarde in his Herball, or Generall Historie of Plantes, says, on page 1391, "We are arrived to the end of our historie, thinking it not impertinent to the conclusion of the same, to end with one of the marvels of this land (we may say of the world). . . . . There are founde in the north parts of Scotland, and the islands adjacent, called Orchades, certaine trees whereon doe growe certaine shell fishes, of a white colour, tending to russet, wherein are contained little living creatures; which shels, in time of maturitie, doe open, and out of them growe those little living things which falling into the water doe become fowles, whom we call Barnakles, in the North of England Brant Geese, and in Lancashire Tree Geese: but the other that doe fall upon the land perish and come to nothing." He then goes on to describe in detail the various transformations by which the barnacle is changed into a goose, saying, "But what our eies have seene and hands have touched, we shall declare." He tells us that when the bird is formed in the shell, the latter gapes, the legs hang out, the bird grows larger, until at length it hangs only by the bill and soon after drops into the water, "where it gathereth feathers and groweth to a fowle bigger than a mallard and lesser than a goose."

A quotation in Walton's Complete Angler repeats the same curious notion: —

"So slow Boötes underneath him sees
In th' icy islands goslings hatched of trees,
Whose fruitful leaves falling into water
Are turned tis known to living fowls soon after.

So rotten planks of broken ships do change
To Barnacles. O transformation strange!
'T was first a green tree, then a broken hull
Lately a mushroom, now a flying gull."

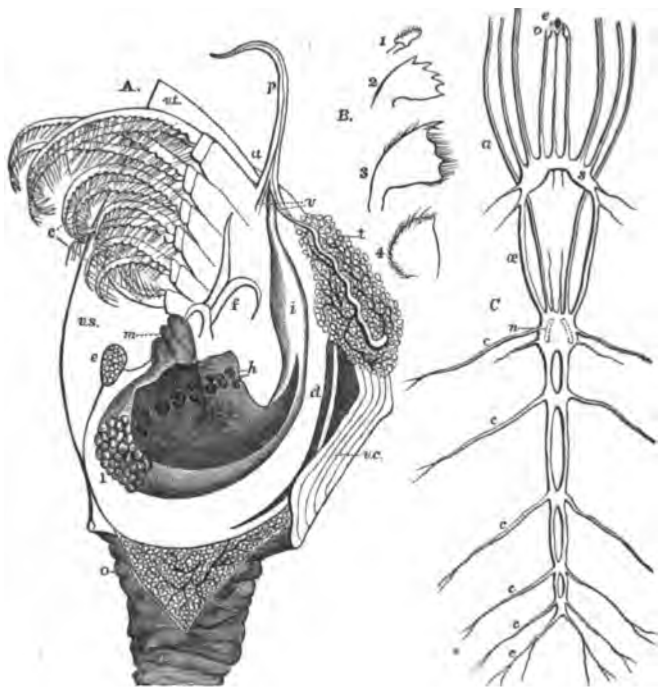
The transformations described by the above authors are, it is needless to say, founded wholly upon fancy, but the metamorphoses observed in a study of the life-history of a barnacle are scarcely less wonderful than those so minutely related by the old botanist. The old idea is still perpetuated in the names of two animals: that of the "Barnacle Goose" (Bernicla), and in the specific name of one species of barnacle, the *Lepas anserifera* of Linnæus.

Barnacles were at first classed among the Mollusca, on account of their calcareous valves, as were at a later date the Brachiopoda; but in 1828–29 John Thompson proved, by studies of their embryology, that they had absolutely no molluscan affinities, but that they were Crustacea. Later investigations of their anatomy have confirmed this and they are now accorded a place among the lowest Crustacea, the Rhizocephala only being below them.

They form the sub-class Cirripedia, and are divided into two orders: the first is the pedunculated Cirripedia, in which there is a *capitulum*, generally formed of calcareous valves, varying in number, and united by membranes, and a tough leathery stalk, the *peduncle*, by which they are attached; in the other order, the sessile Cirripedia, the capitulum has four or more of its valves immovably united, and is directly attached without the intervention of a peduncle.

In Figure 5 we give the anatomy of one of the pedunculated forms, *Lepas fascicularis* of Ellis and Solander. In this species the capitulum is composed of five valves, two on each side, and one on the dorsal edge. The ventral margin is open and the two basal valves are connected by an adductor muscle (*A*, *e*), by which this opening can be closed. To dissect a specimen, it should be placed under water in a wax-bottomed pan and pinned down. In this manner the parts float out and the various organs are easily seen. The valves of one side are removed by cutting the *adductor scutorum* muscle and the membranes uniting them. This discloses a body with six pairs of long ciliated arms, the *cirri* (*A*, *c*), which represent the thoracic feet. Each cirrus consists of a basal portion and two long jointed branches. They decrease in length as we go forward (that is, toward the peduncle). In front of these cirri we find a protruding organ formed by the

mouth parts (A, m). These consist of an upper lip to which is attached a so-called *palpus* (B, 1). Next follow the mandibles (B, 2). Then the two pairs of maxillæ (B, 3 and 4). The maxillipeds, which are found in the higher Crustacea, are wanting. At the base of the first cirrus arise processes, varying in number in different species, which are termed filamentary appendages (A, f). These have been supposed to be part of the respiratory apparatus, but that such is their sole function is at least doubtful.



(Fig. 5.) ANATOMY OF LEPAS FASCICULARIS.

Between the sixth pair of cirri are found two small processes consisting of one or more joints, called the *caudal appendages*, and representing the abdomen of the higher Crustacea. Beneath these arises a long slender organ, the male intromittent organ (A, p).

On opening the body, starting from the mouth, we see first a slender tube, the *œsophagus*, then comes the stomach (A, s), which connects without any defined constriction with the intestine (A, i), and terminates at the vent (A, a), between the caudal appendages. At the anterior part of the stomach are seen the hepatic openings (A, h) which connect with the liver

(*A*, *l*). The circulatory system is very imperfect. There is a dorsal vessel (*A*, *d*) which I have succeeded in injecting; the blood flows between the muscles in broad currents and is not confined in closed vessels. Respiration is probably performed by the whole surface of the body. The barnacles are generally hermaphroditic. The testes (*A*, *t*) are found surrounding the alimentary canal and extending into the filiamentary appendages and the bases of the cirri; they consist of branching tubes connecting with lobular cæca. The *Vasa deferentia* (*A*, *v*) are disposed one upon each side. They follow an undulating course and unite at the base of the penis (*p*) and proceed as a single tube to the end. The ovaries are found in the peduncle (*A*, *o*) and present the same general appearance as do the testes.

The nervous system is easily dissected by laying the specimen upon the dorsal surface (after removing all the valves) and cutting away in front of the œsophagus. This will expose the *supra-œsophageal* ganglia (*C*, *s*), which will be readily recognized, as they present the same shiny white appearance that always characterizes nerves. From the commissure connecting these ganglia a single nerve arises and proceeds forward in the median line. The optic nerves originate on each side, have each an enlargement, the ophthalmic ganglion (*C*, *o*) and unite in the rudimentary eye (*C*, *e*), which is imbedded in the membranes of the body. Exterior to these arise the nerves which supply the peduncle. From the posterior angles of the supra-œsophageal ganglia a nerve on each side (*C*, *œ*) passes backward around the œsophagus and unite in the *infra-œsophageal* ganglion (*C*, *n*). From the anterior portion of this arise the nerves which go to the adductor-scutorum (*C*, *a*) muscle; on the sides the nerves which go to the first pair of cirri have their origin; from the dorsal surface (the under surface as the specimen lies) are given off two nerves which are distributed among the viscera. The second, third, fourth, and fifth thoracic ganglia follow each other, are connected by commissures, and give rise to nerves supplying their respective cirri. The sixth ganglion is almost invariably united to the fifth, and from it arise the nerves going to the sixth pair of cirri and the penis. In one specimen, however, I have found the fifth and sixth ganglia connected by distinct commissures.

In the sessile Cirripedes the internal anatomy does not differ greatly from the form above described. They are best dissected by removing the animal through the base (the portion by which

they are attached), breaking it down if it be calcareous. One curious feature of both orders remains to be noticed, namely, two glands in the peduncle which secrete a cement by which the animals attach themselves.

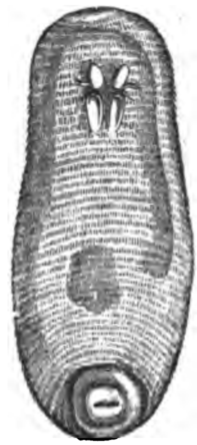
We have said above that the barnacles are generally hermaphrodites. In the case, however, of the genera *Ibla* and *Scalpellum*, this is not strictly the case. In the species of these genera occur specimens of the normal hermaphroditic form, and also females in which the penis and testes are wanting; next we have curious male forms. Certain of these (complemental males they are called) are parasitic upon the hermaphrodites while others are attached to the female individuals. In both cases they live just within the valves and are attached either to the valves or the membranes of the body. These males are imperfectly developed, in some cases without mouth or alimentary canal, in others there is a long and flexible peduncle, and in still others it is not differentiated; the male genital organs are developed, but with the penis short or wanting. (Figure 6, male of *Ibla Cumingii*, from Darwin). This great difference between the sexes has its analogues in the Cephalopoda, where the males of certain species were first described as parasitic worms, and in the Lernean Copepoda, which are closely allied to the Cirripedia.

(FIG. 6.) IBLA, MALE ENLARGED.

(FIG. 7.) SCALPELLUM REGIUM. (From W. Thompson.)
a, Males lodged within the valves.

Recent investigators have shown that close fertilization is the exception, not the rule, among plants, and here seems to be a case in the animal kingdom, where nature plainly shows her preference for cross-fertilization. In those genera which are strictly hermaphroditic,

the animals either occur in groups, as in the genus *Balanus*, or the intromittent organ is extremely long, as in *Acasta*, thus enabling one individual to fertilize another. *Anelasma squalicola* always occurs in pairs in the skin of sharks. But in the two genera, *Ibla* and *Scalpellum*, the individuals are either solitary or, if in clusters, are so crowded and twisted that the apertures of the capitulum are distant from each other.

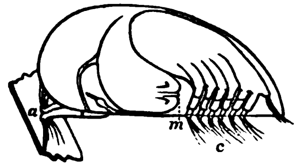


(FIG. 8) MALE OF S. REGIUM ENLARGED. (From W. Thompson.)

The case of a simple separation of the sexes would not strike us as being peculiar; but an instance where a hermaphrodite, with fully developed testes, *vasa deferentia*, and intromittent organ, besides female organs, has within its shell from one to ten complemental males can, I think, be explained only on the ground of adaptation for cross-fertilization.

The eggs pass from the ovaries and are borne for some time inside the capitulum. They undergo a total segmentation of the yolk and hatch a Nauplius, a free swimming form with mouth, stomach, and intestine, a triangular carapace with two prominent frontal horns and a posterior spine, beneath which is seen the forked abdomen. (Figure 9, Nauplius of *Balanus balanoides?* from a MS. drawing by Dr. Packard.) They have three pairs of swimming feet, the first simple, the posterior two biramose, and all three terminating in long bristles. They soon change to a pupa form (Figure 10, pupa of *Lepas australis; a*, antennæ; *c*, cirri; *m*, mouth; from Darwin), which has the triangular shield of the Nauplius folded together in a bivalve form; the six pairs of thoracic limbs are present, and also the antennæ. After swimming about for a while the animal attaches itself by its antennæ, as shown in the figure, and undergoes a metamorphosis by which the eye becomes internal, the antennæ are concealed by the growth of the peduncle, the valves of the capitulum are formed, and, in a word, the animal attains its adult retrograde condition.

(FIG. 9.) YOUNG OF THE BALANUS, ENLARGED.



(FIG. 10.) PUPA OF LEPAS, ENLARGED.

Barnacles first appeared in the upper Silurian age. At the present day they are found in every sea, and the various species are widely distributed. Some are attached to piles and rocks; *Acasta* is found in sponges, *Lepas fascicularis* forms of its cement a float by which it is supported, *Coronula* is found in the skin of whales; *Anelasma squalicola*, as its name indicates, inhabits the skin of sharks; *Chelonobia* is found on the backs of turtles in the tropical seas. There is an interesting specimen in the Museum of the Peabody Academy of Science at Salem, Mass., of *Conchoderma aurita* which had attached itself to a Lernean Crustacean (*Penella*), which in turn was parasitic upon the large sunfish (*Orthagoriscus mola*).

The anatomy of the Cirripeds has been worked out by Burmeister, St. Ange, and Darwin. The figure of the nervous system given by St. Ange is wonderfully imperfect. It has, however, been copied by Coldstream in Todd's Cyclopædia of Anatomy, in Owen's Lectures on Invertebrate Anatomy, and Carus Icones Zoötomie. Their embryology has been studied by Thompson, Burmeister, Darwin, and Fritz Müller, while a systematic account of the subclass is given by Darwin in two volumes published by the Ray Society, to which the reader is referred for further particulars concerning this interesting group.

RECENT LITERATURE.

THE ZOÖLOGY OF WHEELER'S SURVEY.[1] — Since the spring of 1871, Lieutenant Wheeler has been conducting an examination of the biology of the Western Territories, which his parties have traversed, in connection with his geographical and geological explorations. No connected reports upon the facts and material obtained by the survey have ever been published, however, and our knowledge of them has been limited, with one or two exceptions, to brief accounts of discoveries read to scientific societies. The publication of this splendid volume of zoölogical results is therefore an event in the history of this survey, — one which is calculated to increase its friends, — and a monument to the perseverance and skillful zeal of the field naturalists.

The report contains over one thousand quarto pages, and is made in the name of Dr. H. C. Yarrow, who, until recently, was naturalist-in-charge of the survey; but he acknowledges assistance in the prepara-

[1] *Reports upon the Zoölogical Collections obtained from Portions of Nevada, Utah, California, Colorado, New Mexico, and Arizona, during the Years* 1871–74. Explorations and Surveys west of the One Hundredth Meridian. Lieut. Geo. M. Wheeler in charge. Volume V. Washington. 1875. 4to, pp. 1020.

tion of special features from a large corps of well-known scientific men. The opening paper treats of the geographical distribution of the animal life of the West, as shown by Lieutenant Wheeler's explorations. This is followed by the account of the mammals observed, written by Dr. Elliott Coues and Dr. Yarrow, which goes extensively into the synonomy of the species mentioned, and gives copious notes upon habits, etc. Although the collections were large there were no novelties, and hence no plates accompany this paper. Chapter III., Ornithology, is by Mr. H. W. Henshaw, and is illustrated by fifteen plates of new species or varieties of birds. They are drawn by Robert Ridgway, and well drawn, but the chromo-lithographic process of coloring has failed to give a worthy effect in several cases, and some of the plates look cheap. The text of the Ornithology is full of news, and great praise belongs to Mr. Henshaw for his active and careful observance of the manners and songs of the little-known birds of the Southwest. This is the most entertaining and the longest chapter in the volume. Dr. Yarrow himself writes the report upon the Batrachians and Reptiles, of which a large series of great value was secured, and unites with Prof. E. D. Cope in describing the fishes, which have been somewhat neglected by Western expeditions heretofore. Both of these papers are accompanied by many finely engraved plates, partially colored; and both are preceded by a discussion of general characteristics. The collections of Hymenoptera are reported upon by E. T. Cresson and Edward Norton; the Diurnal Lepidoptera, by Theodore L. Mead and W. H. Edwards; new species of *Zygænidæ* and *Bombycidæ*, by Richard H. Stretch; the Diptera, by Baron Osten-Sacken; the Coleoptera, by Henry Ulke; the Hemiptera, by Professor Uhler; the Orthoptera, by Professor Thomas; and the Neuroptera, by Dr. Hagen. Dr. Yarrow, with quite unnecessary apologies as to unfitness, presents the report upon the Mollusks, showing that even the more barren plains of New Mexico and Utah support many species of terrestrial and fluviatile mollusks, as well as the mountain meadows of the more Northern Territories; and extending almost or quite across the continent, the range of some of our common Eastern species. The final chapter is by Professor Verrill upon fresh-water leeches. This last half of the book, also, is adorned with a large number of plates finely drawn and exquisitely colored.

WEISMANN'S FINAL CAUSES OF TRANSMUTATION.[1] — Perhaps the most remarkable biological work of the year is Prof. August Weismann's treatise on the Final Causes of Transmutation, forming the second part of his Studies on the Theory of Descent. The first part of the work, entitled Seasonal Dimorphism, appeared in 1875. The present work is divided into four divisions, of which the first presents a striking array of

[1] *Studien zur Descendenz-Theorie. II. Ueber die letzten Ursachen der Transmutationen.* Von Prof. AUGUST WEISMANN. Mit fünf Farbendrucktafeln. Leipzig. 1876. 8vo, pp. 336.

facts on the origin of the markings of caterpillars. The author describes the nature and morphology of the markings of larvæ of the family Sphingidæ, their biological value and tribal development, concluding that the oldest Sphingid caterpillars were without markings; that the oldest style of markings were longitudinal lines, the later ones oblique streaks, and the last to be developed, the spots. This part of the subject is illustrated by five colored plates. In the third section the transformation of the Mexican axolotl into an Amblystoma is discussed at considerable length, and with characteristic thoroughness. Professor Weismann believes that the Siredon or axolotl was originally derived from a land salamander (Amblystoma), but has reverted to an axolotl, or larval form, through the change of the climate of Mexico from a damp to an exceedingly dry one, obliging these animals, which as larvæ, lived in ponds, and as adults lived under fallen trees and stones or in damp places, to revert to the original larval Siredon form and remain permanently amphibious. In the fourth division, on the mechanical conception of nature, the author maintains that development is mechanical, and that we must reject the idea of a special life-force. Still he as strongly believes in teleology, and maintains the thesis that evolutional views do not tend to materialism.

GLOVER'S ILLUSTRATIONS OF INSECTS.[1] — This is a large quarto volume, containing ten excellent copper-plates illustrating the leading types of plant-bugs (Hemiptera not including the Homoptera), with 132 pages of text, a fac-simile of the author's own handwriting, printed on prepared lithographic paper. The letterpress contains useful lists of predaceous or parasitic bugs (Heteroptera), of the vegetable or animal substances destroyed by them, and of remedies against their attacks used or suggested by various writers. The value of the work is greatly increased by the aid of Mr. P. R. Uhler, "who has materially assisted in preparing the work by furnishing the specimens from which to figure, for advice and correcting the text, for the classification and valuable notes." The edition consists of but fifty or sixty copies for private distribution, and is a storehouse of useful information for agriculturists, which we wish could be more widely published.

LOVÉN'S STUDIES ON THE ECHINOIDS.[2] — This elaborate memoir presents matter of special interest to the palæontologist as well as to the zoölogist and anatomist. Chiefly zoölogical in its character, the text and plates are mostly devoted to a discussion of the homologies of the shell of the sea-urchins, particularly those forms related to extinct genera of echinoids. Comparisons are also instituted with the classes of

[1] *Manuscript Notes from my Journal, or Illustrations of Insects, Native and Foreign. Order Hemiptera, Suborder Heteroptera, or Plant-Bugs.* By TOWNSEND GLOVER. Washington, D. C. 1876. 4to, pp. 132.

[2] *Études sur les Échinoïdées.* Par S. LOVÉN. (Kongl Svenska Vetenskaps-Academiens Handlingar. Bandet II., No. 7.) Text and Atlas of 53 Plates. Stockholm. 1875. 4to, pp. 91.

Asteroids (star-fish) and Crinoids, which will, if we mistake not, be found of much use to palæontologists. Especial attention is devoted to certain organs called *Spherides*, grouped around the mouth of sea-urchins, for the discovery of which naturalists are indebted to Professor Lovén.

But to our mind the most interesting portion of the work is the exquisite drawings illustrating the anatomy and distribution of the nervous system and the water system of vessels. We have here for the first time, clearly shown, the more intimate relations of these organs.

The plates are abundant and beautifully executed, the lithographs rivaling in clearness and delicacy the best steel engravings.

MACALISTER'S ANIMAL MORPHOLOGY.[1] — Though this book was written in 1873, it is still the most recent manual of animal morphology in the English language, and will be found by advanced teachers to be very useful. The system of classification is that of Haeckel as modified by Huxley, and is based on recent embryological studies. The sponges are regarded as belonging to a distinct subkingdom, *Polystomata* of Huxley. The *Labyrinthuleæ* of Cienkowsky are admitted as a class of Protozoa. The Mollusca are regarded by the author, and we think correctly, as "only an extreme of specialization" of Vermes; in another place (page 241), "Their structure can be easily understood by regarding them as Vermes with no articulated appendages, modified by unequal lateral development, and by a fusion of metameres." For convenience they are regarded as a subkingdom. The Tunicates are placed among the Vermes in accordance with Gegenbaur's classification. The Polyzoa are placed among the Vermes, while rather inconsistently (probably because Gegenbaur first did so) the Brachiopoda are retained among the Mollusca. The volume ends with the Insects; a second volume, containing the Vertebrates, has just been issued from the press. Had we space to be critical we should feel inclined to find some fault with the author's classification of the Arthropoda, which he does not, however, claim to be original.

RECENT BOOKS AND PAMPHLETS. — Report on the Transportation Route along the Wisconsin and Fox Rivers, in the State of Wisconsin, between the Mississippi River and Lake Michigan. By Gen. G. K. Warren. Washington. 1876. 8vo, pp. 114. With Ten Maps.

The Grotto Geyser of the Yellowstone National Park. With a Descriptive Note and Map, and an Illustration by the Albert-type Process. (U. S. Geological and Geographical Survey of the Territories, F. V. Hayden, U. S. Geologist-in-Charge.) Washington, D. C. Folio.

The History of Spontaneous Generation. By Edward S. Dunster, M. D. (From Transactions of the Ann Arbor Scientific Association. Vol. i. 1871.) Ann Arbor. 8vo, pp. 30.

Über Dimorphismus und Variation einiger Schmetterlinge Nord Amerikas. Briefliche Mittheilung von J. Boll in Texas. 1876. 4to, pp. 3.

[1] *An Introduction to Animal Morphology and Systematic Zoölogy.* By ALEXANDER MACALISTER, Professor of Comparative Anatomy and Zoölogy, University of Dublin. Part I. Invertebrata. London: Longmans, Green, & Co. 1876. 12mo, pp. 461. With a few Cuts.

New England Society of Orange, N. J. Scenery. I. October, 1876. 4to.

Mesozoic Fossils. Vol i. Part I. On some Invertebrates from the Coal-Bearing Rocks of the Queen Charlotte Islands, collected by Mr. James Richardson in 1872. By J. F. Whiteaves. Geological Survey of Canada. Montreal, 1876. 8vo, pp. 92. Ten Plates and Map.

The Origin of Californian Land Shells. By J. G. Cooper, M. D. (From the Proceedings of the California Academy of Sciences, February 1, 1875.) 8vo, pp. 3.

On Shells of the West Slope of North America. By J. G. Cooper, M. D. (From the Proceedings of the California Academy of Sciences, February 1, 1875.) 8vo, pp. 17.

New Facts relating to Californian Ornithology. No. 1. By J. G. Cooper, M. D. (From the Proceedings of the California Academy of Sciences, December 6, 1875.) 8vo, pp. 14.

On the Coal and Tertiary Strata of California. By J. G. Cooper, M. D. (From the Proceedings of the California Academy of Sciences, September 21, 1874.) 8vo, pp. 15.

Pacific Coast Lepidoptera. No. 15. Description of a new Species of Catocala, from San Diego. By Henry Edwards. (From the Proceedings of the California Academy of Sciences, October 18, 1875.) 8vo, pp. 1.

Pacific Coast Lepidoptera. No. 16. Notes on the Transformations of some Species of Lepidoptera, not hitherto recorded. By Henry Edwards. (From the Proceedings of the California Academy of Sciences, April 19, 1875.) 8vo, pp. 6.

Pacific Coast Lepidoptera. No. 17. On the Transformations of Colias (Meganostoma Reak) Eurydice Bdv. By Henry Edwards. (From the Proceedings of the California Academy of Sciences, June 5, 1876.) 8vo, pp. 2.

Darlingtonia Californica Torrey. By Henry Edwards. (From the Proceedings of the California Academy of Sciences, September 6, 1875.) 8vo, pp. 6.

Notice of Sir William Edmond Logan. By T. Sterry Hunt, LL. D. (From the Report of the American Academy of Arts and Sciences, May, 1876.) 8vo, pp. 6.

On the Affinities of Hypocephalus. By John L. Leconte, M. D. (Read before the National Academy of Sciences, October 10, 1876.) 8vo, pp. 10.

The Rocky Mountain Locust or Grasshopper. Being the Report of Proceedings of a Conference of the Governors of several Western States and Territories, together with several other Gentlemen, held at Omaha, Nebraska, on the 25th and 26th days of October, 1876, to consider the Locust Problem. 8vo, pp. 58.

Sopra Alcuni Opilioni (Phalangidea) d'Europa e dell'Asia Occidentale, con un quadro die Generi Europei, di Quest' Ordine. By Prof. T. Thorell. Genova. 1876. 8vo, pp. 57.

Enumerazione dei Rettili raccolti dal Dott. O. Beccari in Amboina, alle Isole Aru, ed alle Isole Kei, durante gli Anni 1872-73. By G. Doria. Genova. 1875. 8vo, pp. 33. Two Plates.

Elenco di una Collezione di Rettili raccolti a Bintenzorg (Giara) dal Signor G. B. Ferrari, ed inviati in dono al Museo Civico di Genova. By G. Doria. 8vo, pp. 6.

Diagnosi di Alcune nuove Specie di Coleotteri raccolte nella regione Austro-Malese dai Signori Dott. O. Beccari, L. M. d'Albertis, e A. A. Bruijn. By R. Gestro. 8vo, pp. 13.

Descrizione di una nuova Specie di Eupholus (Eupholus Bennettii n. sp.) By R. Gestro e L. M. d'Albertis. 8vo, pp. 3.

Note sopra Alcuni Carabici, appartenenti al Museo Civico di Genova, con Descrizioni di Specie nuove. By R. Gestro. 8vo, pp. 45. Illustrated.

Descrizione di un nuovo Genere e di Alcune nuove Specie di Coleotteri Papuani. By R. Gestro. 8vo, pp. 35.

Descrizione di Tre nuove Specie di Cicindelidi del l'Isola di Borneo. By R. Gestro. 8vo, pp. 4.

Descrizione di Tre Specie nuove del Genere Atractocerus appartenenti alle Collezioni Museo Civico di Genova. By R. Gestro. 8vo, pp. 4.

Osservazioni sopra Alcune Specie Italiane del Genere Cychrus. By R Gestro. 8vo, pp. 7.

Enumerazione dei Cetonidi, raccolti nell' Arcipelago Malese e nella Papuasia, dai Signori G. Doria, O. Beccari, e L. M. d'Albertis. By R. Gestro. 8vo, pp. 31. Appendix, pp. 28.

Note sopra Alcuni Coleotteri appartenenti alle Collezione del Museo Civico di Genova. By Dr. R. Gestro. 8vo, pp. 13.

Note sopra Alcuni Coleotteri appartenenti alle Collezione del Museo Civico di Genova. Nuova Specie del Genere Zanthe. By Dr. R. Gestro. 8vo, pp. 8.

GENERAL NOTES.

BOTANY.[1]

FERTILIZATION OF GENTIANA ANDREWSII. — Humble-bees are in the habit of entering bodily into the flower of this gentian, forcing open the mouth of the corolla to do so where this is closed, as it is in the absence of sunshine, and the anthers open before the stigmas separate to expose the pollen-receiving surface; so it is evident that cross-fertilization is provided for. Our correspondent, Mr. M. W. Vandenberg, of Fort Edward, N. Y., communicates the result of some observations which show that this flower has likewise an arrangement for self-fertilization. The short tube of cohering and extrorsely opening anthers is higher than the stigma when the blossom first opens. The pistil afterwards lengthens, so that its apex protrudes; the broad and introrse stigmas now separate, at first moderately, but at length they diverge strongly and become revolute, so as to bring a portion of the broad stigmatic surface into contact with the outer face of the anther tube, which usually is still covered with abundance of pollen. The pollen appears to retain its freshness for a long time, and in this slow movement of revolution of the stigmas they are seen to take up considerable masses of the moist pollen. Those stigmas, therefore, which have failed to receive extraneous pollen from bees during the first day or two of anthesis, will afterwards secure it from their own anthers. "Get fertilized, cross-fertilized if you can, self-fertilized if you must, is nature's golden rule for flowers." — A. GRAY.

ORIGIN OF VARIETIES; TWO ILLUSTRATIONS. — Eight or ten years ago, on a plot of ground where I had grown beet seed of the early turnip variety, after the crop had been gathered from the seed that had dropped on the ground, there sprang up thousands of young plants. A large proportion of these lived through the winter. It is my impression that they had the protection of a thick growth of chick-weed. In the following spring, when plowing, these plants were so forward I left a portion of the piece unplowed, with the view of obtaining a

[1] Conducted by PROF. G. L. GOODALE.

crop of early beets. As the plants grew quite a number pushed seed shoots, and as the season advanced ripened a small crop of seed, which I saved in a mass, and the next season planted a portion of it. Here I will note, that all the beets from which the first crop of seed grew were of one variety, and being for seed purposes were very carefully selected at that time; and that the seed that was gathered from them in the autumn when planted the next season produced a crop pure and true to name; also, that the field in which the two crops of seed grew was in the middle of a great pasture, very isolated; and finally, that no other beet seed was raised there. Now, as to the result, the beets raised from this second crop of seed were, to use an expressive word, "everything," ranging all the way from a small, very dark-fleshed variety, through a score or more of kinds of various color, form, and texture, down to a light-fleshed, medium long variety of mangel-wurzel, which, as farmers know, is a very coarse-fleshed kind raised for the feeding of stock.

My other illustration is an experiment with Indian corn. With this I have had no personal experience, but a very intelligent correspondent writes me, that seeing occasionally the spindle of his corn (he was raising the Dutton variety) replaced by small ears, he was led from curiosity to save and plant the kernels of some of these. The result was, he obtained a vast number of entirely new varieties each having characteristics of its own. I wonder if other experimenters (we farmers, mind you, don't propose to leave all the experimenting with you men of science!) may not have something to put on record about — say the short-horn variety of carrot, which probably more than any other tends to push occasional seed shoots the first season? — J. J. H. GREGORY.

IPOMŒA SETOSA. — We succeeded in growing the rare plant, *Ipomæa setosa*, in Florida last year. The seed was found among some "Java" coffee and planted in rich soil. On the 17th of May, when we left Florida for the North, the plant was about six inches high. Upon our return, the first of November following, to our surprise the plant had completely covered a small live-oak. The main stem of the vine was about fifteen feet in length and six inches in circumference at the base, with numerous large branches radiating in all directions. Had the support been taller the plant would have climbed much higher; as it was, it clambered about in all directions, entirely covering the tree, the various subdivisions reaching the top of the tree and falling back to the ground, thus making more than thirty feet of length. The support was a living tree, but the great weight of the vine broke every branch, leaving the bare trunk standing.

Frost came the first of December, cutting it down while still a mass of bloom, and great clusters of unripe seed, fully enough to have made a peck of ripe seed, if frost had kept off as late as the year before. As it was, we did not save a pint of seed.

The flowers were large and of a bright pink color; leaves large and lobed, and the stems and peduncles covered with soft prickles.

I sent specimens of the foliage and unripe fruit to Professor Sargent, Director of the Botanic Garden of Harvard University, for identification. His reply is as follows: "Your morning-glory seems to be *Ipomæa setosa* Lindl., a little-known species; it occurs in Jamaica as an introduced plant from Brazil, while the flora of Brazil is doubtful of its nativity. At any rate you have a most interesting plant. If possible send good herbarium specimens of flowers and foliage, and by all means a good supply of ripe seed. You will do well to plant several seeds in order to secure a crop of seed for next year for general distribution, as there is no chance that seed will ripen here, either in the garden or under glass. This plant flowered in England as long ago as 1818, but is long since lost to cultivation. So you will be conferring a great benefit on cultivators by re-introducing it."

All the seeds that we can spare this year, we shall send to Professor Sargent for him to distribute as he thinks best.

The remarkable growth of the plant was in a great measure owing to the soil in which it grew. It was planted on a terrace adjoining the St. John's River. The terrace is made mostly from muck taken from the river. Some weeds grew here to the size of small trees. One amaranth attained the height of twenty-five feet and eighteen inches in circumference, and several others approximated this. — MARY TREAT.

OBJECTS OF THE DIVERSITIES IN THE MODE OF ARRANGEMENT OF THE FLORAL ORGANS. — In the paper by Dr. Masters, elsewhere referred to, occurs the following passage which will be of interest to our readers: "The alternate position seems to be in most instances a provision for ensuring space to closely packed organs, so as to prevent undue amount of pressure on the growing tissues. In cases where the development of the stamens lags behind that of the petals, the question of space is not of so much moment as under other circumstances. It may often be an advantage to the plant to have the stamen concealed in the cavity of the petal, ... where such an arrangement may be beneficial either for protection's sake, or in various manners connected with fertilization. In other cases the existing arrangement may be a relic of some ancestral condition which has now lost its significance; or, on the other hand, could we but read it aright, it might offer a forecast of some future development."

BOTANICAL PAPERS IN RECENT PERIODICALS. — *Journal of the Linnæan Society, Botany.* December 15th. T. H. Potts, Habits of Filices observed about the Malvern Hills, Canterbury, New Zealand. S. H. Vines, On the Digestive Ferment of Nepenthes. (The following facts are regarded by the author as established by his experiments: (1.) The glands of the pitchers of Nepenthes contain a digestive ferment which is soluble in glycerine, and which can exert its digestive action only in the presence of acid. The fact of digestion was clearly made out by Von Gorup-Besanez, May 22, 1876; (2.) the digestive fer-

ment exists at first in the gland-cells of the pitchers, in combination with some other body, as zymogen, and this zymogen is split up by the action of dilute acid, the free ferment making its appearance as the result of this decomposition. The author further states, that the experiments run perfectly parallel with those of Ebstein and Grützner on the stomach, and with those of Heidenhain on the pancreas.) J. M. Crombie, An Enumeration of Lichens from Rodriguez Island. (Twenty-five new species are described.) W. Archer, On Fresh-Water Algæ from Kerguelen's Land. (According to the author, who found nothing new in the collection, the algal flora of this remote and isolated spot is not unlike that of England. Mr. Reinsch described early in this year three new genera and thirty new species from this region.) Professor Dickie, Algæ from the Coasts of Japan, and from Juan Fernandez. Dr. Masters, On the Superposed Arrangement of the Parts of the Flower. (An attempt to explain anteposition by referring special cases to the following causes: (1.) Superposition of whorls. (2.) Spiral arrangement of parts, the calyx forming a complete cycle, followed by the corolla in like manner. (3.) Enation, or outgrowth, and chorisis, or division. (4.) Abortion, the most common cause. (5.) Multiplication of parts. (6.) Interposition. (7.) Substitution of one organ by another. (8.) Torsion of the axis.)

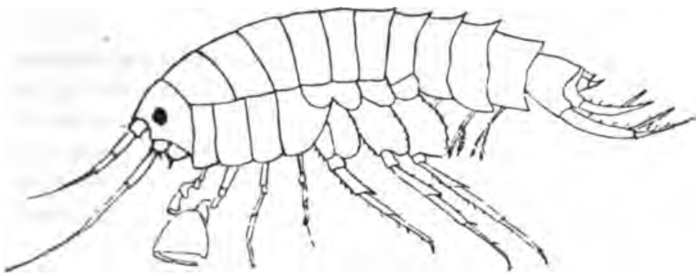
Flora, No. 3. Westermaier, The First Cell Division in the Embryo of Capsella Bursa-Pastoris. Nylander, On New Cuban Lichens (Species of Lecanora).

Botanische Zeitung, Nos. 43 and 44 not yet at hand. No. 45. Kienitz-Gerloff, On the Genetic Connection of Mosses with Vascular Cryptogams and Manerogams. (Continued in No. 46.)

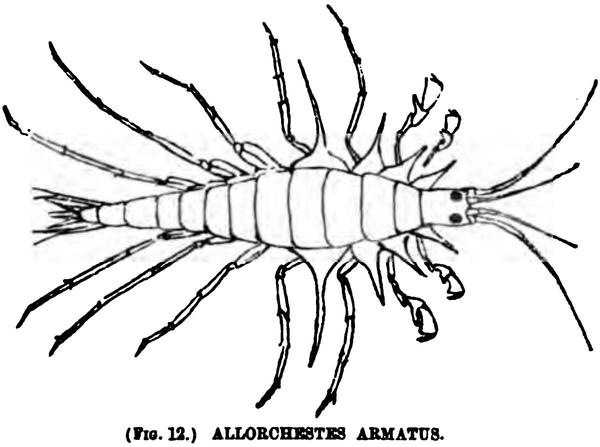
ZOÖLOGY.

THE CRUSTACEA OF LAKE TITICACA. — In the Naturalist (x., 380) we have called attention to the exploration of Lake Titicaca, by Messrs. Agassiz and Garman, and alluded to the marine nature of the crustacean fauna of this lake. Since then Mr. W. Faxon has published, in the Bulletin of the Museum of Comparative Zoölogy, descriptions and figures of the crustacea of the lake. "Excepting," he remarks, "a species of *Cypris*, all the specimens collected belong to one amphipodous genus, *Allorchestes*, which had hitherto afforded but one or two authentic fresh-water species, ranging from Maine to Oregon and the Straits of Magellan. Seven new species are described in this paper from Lake Titicaca. Several of them are remarkable among the *Orchestidæ* for their abnormally developed epimeral and tergal spines. Some are also noteworthy as comparatively deep-water forms of a family commonly regarded as preëminently littoral. I believe that no *Orchestidæ* have heretofore been found at a depth so great as sixty-six fathoms,[1] unless it be *Orchestia* (*Talitrus*) *Brasiliensis* Dana, and *Nicea media* Dana,

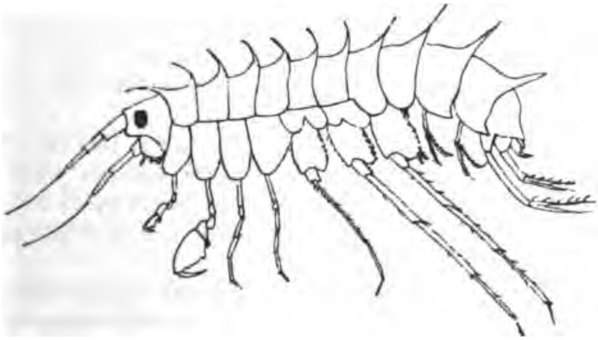
[1] The greatest depth of the lake is 154 fathoms.



(FIG. 11.) ALLORCHESTES LATIMANUS.



(FIG. 12.) ALLORCHESTES ARMATUS.



(FIG. 13.) ALLORCHESTES LUCIFUGAX.

(FIG. 14.) ALLORCHESTES ECHINUS.

(FIG. 15.) ALLORCHESTES DENTATUS.
Var. inermis.

dredged in the harbor of Rio Janeiro (at what depth is not specified) by the Wilkes Exploring Expedition. The marine species usually inhabit the shores above low-water mark, and the previously described fresh-water species are found in the shallow water of brooks, pools, or edges of lakes." To give some idea of the different forms of these crustacea we have inserted a portion of the figures prepared by Mr. Faxon and kindly loaned by Mr. Agassiz.

ANTHROPOLOGY.

MORE CORDATE ORNAMENTS. — Since my note on this subject in the January Naturalist has been placed in the hands of the printer, two more cordate ornaments have been brought to my notice. One is in the collection of J. H. Jenkins, having been found in a mound in Warren County, Ohio, lying on the neck of a corpse. It is made of a hard stone, flat on both sides and measures about four and a half inches in length, three and a half across the broadest portion of the lobes, and half an inch in thickness, the edges being cut squarely and the notch deeply.

The second specimen is now in the possession of Mr. William S. Vaux, of Philadelphia, and is somewhat similar. A sufficient number of these objects, therefore, have been thus far discovered to establish the type, which, so far as I know, is a new one, and all doubt is removed as to its aboriginal origin. — E. A. BARBER.

ANTHROPOLOGICAL NEWS. — *Nature* for October 26th contains an abstract of a paper on Cave-Hunting, read before the Philosophical Institute of Canterbury, N. Z. The paper describes the inspection of the Moa-Bone Point Cave, on the east side of the middle island, in Banks' Peninsula. From the results of the excavations, Dr. Haast infers that a very long time has elapsed since the extinction of the moas in that part of the island.

A recent census in the schools of Prussia showed that out of 4,127,-766 persons examined, 4,070,923 were under fourteen years of age 42.97 per cent. had blue eyes, 24.31 per cent. brown eyes; 72 per cent. had blonde hair, 26 per cent. had brown hair, and 1.21 per cent. had black hair; 6.53 per cent. were brunettes.

During the coming winter, free lectures on anthropology will be given in Paris, at the École libre d'Anthropologie, by MM. Broca, Topinard, Dally, Mortillet, and Hovelacque. The following gentlemen in Paris have signed a paper, binding each one to make a will, directing that upon his decease his brain shall be sent to the Anthropological Society for inspection: MM. Hovelacque, Dally, Mortillet, Broca, and Topinard. The motive of this singular pledge is to afford facilities for inspecting the brains of men whose special mental pursuits are definitely known, in order to see whether there is any connection between the structure and aspect of that organ and its well-known operations.

In the *Academy* for September 30th, October 21st, and 28th, is an interesting discussion between the Rev. Moncure D. Conway and Mr.

Frederick Poynder; the former strenuously maintaining "that all those pictures of Hindoos casting themselves beneath the Juggernaut car, to be crushed, were purely imaginary." In his latest communication Mr. Conway endeavors to prove that Mr. Claudius Buchanan and the Abbé Dubois were not competent observers.

In acknowledging, at the French Association, the labors of M. Tubino on the populations of the Iberian peninsula, M. Broca says there is a true anthropological similarity between the Spanish peninsula and the north of Africa, and indeed the Canary Islands. I will go further and insist upon the analogy which I have already remarked between the Cro-Magnon race and the Guanches of Teneriffe. I believe that at an epoch anterior to the rupture of the Straits of Gibraltar, a stratum of population extended from Perigord, at least, on the north, to Africa and the Canaries on the south. I have always been struck with the similarity between the Spanish Basque and the Berber skulls. In the caverns near Gibraltar, which date back certainly to the polished-stone age, crania were found, the similitude of which to Basque skulls struck Mr. Busk as well as myself.

In *Matériaux*, No. 9, L. Pigorini publishes a list of the provinces in Italy wherein bronze objects are found, and of the particular kinds which are found in each province. The presence of knives, celts, fibulæ, spear-heads, etc., show us that "the men of the bronze age in the peninsula had the same manners and customs as those of the same age in France. — O. T. MASON.

ANTIQUITIES NEAR NAPLES. — During a summer spent in the neighborhood of Naples, I had the pleasure of examining some objects, evidently prehistoric, and of visiting the locality in which they were found, the cemetery of the Piano of Sorrento, formerly called *Casa Talamo.* In the excavation of a long ditch, made, according to the prevailing Italian custom, for the interment of the poor, at a depth of more than six feet, was found hollowed in the *tufa* a cavern, cut smooth, the floor as well as the arch, more than a yard in height, two in width, and two in length. Within it were several objects of great antiquity. Among these were three articles of the simplest form of pottery. One was a vase of terra cotta, with a handle, the largest circumference being ornamented by perpendicular lines, inclosing spaces, every other one of which was lightly and lineally punctured. The height of this vase was about twenty-nine centimetres, and its largest circumference eighty-three.

Another vase was of unbaked earth, without any ornamentation or handle, and broken upon one side. Its height was about twenty-seven centimetres, and its largest circumference seventy-eight. There was also a little cup, of very primitive terra cotta, without ornament, the handle broken off. The objects in flint were six or seven small arrow-points, quite delicately cut. There was an instrument of sandstone, roughly cut, diminishing to a blunt point. Its length was twenty-one centimetres, and

its diameter three. The only entire object in metal was a poniard, the layers of the blade peeling off and broken. It measured thirty-five centimetres in length. There was a point of another.

Lastly, there was a human bone completing the contents of the cavern, which is now no longer accessible, the ditch having been filled with dead and closed. The objects, however, are carefully preserved in the municipal building of the Piano. — CLARA L. WELLS, Rome, October 19, 1876.

GEOLOGY AND PALÆONTOLOGY.

NEWBERRY'S GEOLOGY OF PARTS OF NEW MEXICO AND UTAH.[1] — Although much of the region surveyed by Professor Newberry in 1859 has been reëxamined by later explorers, yet geologists will be interested in this account of the independent observations of so distinguished an observer, while the traveler and explorer will be attracted by the fine colored views of the more striking points in the scenery of the route surveyed. The report is divided into seven chapters, and is accompanied by eleven chromo-lithograph plates of views taken in Northwestern New Mexico, Southwestern Colorado, and Southeastern Utah. Eight plates accompanying the palæontological descriptions of Mr. Meek and Professor Newberry illustrate the fossil shells and plants. Archæologists will be interested in the account on page 41 of the ancient mines of turquois, or *chalchuitl*, situated in Los Cerillos Range in New Mexico, as well as in the views and account of the ancient ruins of the San Juan Valley, which this party was one of the first to visit.

GEOGRAPHY AND EXPLORATION.

WARREN'S IMPROVEMENTS OF THE FOX AND WISCONSIN RIVERS.[2] — In a report of over one hundred pages, illustrated by ten maps and plates, Gen. G. K. Warren, who has long been connected with Western and Eastern river improvements, and in so doing has always had an eye to the scientific relations of the subject before him, gives a historical sketch of the discovery of the route of these two rivers, with plans for their improvement by a canal. By the maps and scattered observations the report is rendered one of much general geological and geographical interest.

SIMPSON'S EXPLORATIONS ACROSS THE GREAT BASIN OF UTAH. — To those interested in Western geography this volume (which has been in MS. since 1860) will have an especial interest. Not only is it valu-

[1] *Report of the Exploring Expedition from Santa Fé, New Mexico, to the Junction of the Grand and Green Rivers of the Great Colorado of the West, in* 1859, *under the Command of Capt.* (*now Col.*) *J. N. Macomb, U. S. Engineers.* With Geological Report by Prof. J. S. NEWBERRY. Washington, D. C. 1876. 4to, pp. 148. With maps and plates.

[2] *Report of Explorations across the Great Basin of the Territory of Utah, for a Direct Wagon Route from Camp Floyd to Genoa, in Carson Valley, in* 1859. By Capt. (now Col.) J. H. SIMPSON, U. S. Engineers. Washington. 1876. 4to, pp. 495. Maps and 17 plates.

able from the large mass of unpublished facts regarding the region traversed, but from the historical *résumé* of explorations made in the Great Basin from 1776 until 1869, given by Colonel Simpson, and from the abstracts and quotations from Father Escalanti's MS. journal, now said to be treasured up in the city of Mexico, and of which a copy was contained in the library of Col. Peter Force, of Washington. Besides the itinerary by Colonel Simpson, and several appendices giving the astronomical, meteorological, and geographical results of the expedition, there are valuable reports on the geology, palæontology, natural history, and ethnology chiefly of Utah, including elaborate treatises on the ichthyology by Professor Gill, and on the botany of the route by Dr. Engelmann, both of which are accompanied by numerous plates.

RECENT CHANGES OF LEVEL OF THE GREAT SALT LAKE. — The party which started about seven days ago under Captain D. L. Davis to explore the western shore of the Great Salt Lake returned last evening after a successful trip. Starting from near Farmington, the party touched at Church Island and then sailed direct to Strong's Point, where the old triangular monument, erected by Stansbury, was found intact. The lake was found to have risen so that many miles marked as lake shore on the maps is now from six to ten feet under water. The Water Witch sailed "inland" for about twelve miles, when the occupants waded ashore and took observations, but it was found that there is a general elevation of the land, which, though slight, precludes the possible lowering of the lake in this direction. The party then beat along the shores northward as far as Kelton, landing frequently to make observations and take angles. It was found, however, that the shifting of the lake westward was an impossibility. Touching at Fremont Island, the company returned with the problem answered, but not satisfactorily. — *Salt Lake Times*, September 14, 1876.

MICROSCOPY.[1]

CLEANING DIATOMS WITH GLYCERINE. — Mr. James Neil, of Cleveland, uses glycerine as an easy and efficacious means of separating diatom shells from the foreign matter with which they are naturally mixed. He fills a two-ounce graduated measuring glass three quarters full of glycerine and water mixed in equal parts. The diatoms after being treated with acid and thoroughly washed, are then shaken up in some pure water and poured gently over the diluted glycerine. If carefully done the water and diatoms do not at first sink into the glycerine, but gradually the diatoms sink through the water, and into the glycerine, preceding the light flocculent matter held in the water. After a few minutes, a pipe introduced closed through the water and into the glycerine will bring up remarkably clean diatoms, which are to be afterward freed from glycerine by repeated washing and decanting. Coloring the water in which the diatoms are held is thought to aid in watching

[1] Conducted by DR. R. H. WARD, Troy, N. Y.

the progress of the operation. This method has been tried thus far on Richmond earth, in which the diatoms are heavier than the adherent matter, but it is believed to be generally applicable.

CUPRO SCHEELITE. — This new mineral which occurs in different parts of California, and which resembles scheelite in which a part of the lime is replaced by oxide of copper, was first described and named by Professor Whitney. Mr. Hawks, in describing it to the San Francisco Microscopical Society, stated that when first discovered it was thought to be a mechanical mixture of scheelite with some copper mineral, but that a careful examination under the microscope showed it to be perfectly homogeneous. The decision of the microscope was subsequently confirmed by the discovery of crystals of the mineral, which proved it to be a distinct and new species.

SCIENTIFIC NEWS.

— On the 28th of December, 1876, died at the Smithsonian Institution, in the fifty-ninth year of his age, F. B. Meek, long connected with the Institution as a volunteer assistant in the department of palæontology.

Mr. Meek was of Irish extraction, his parents having settled in Indiana some sixty years ago, and shortly after his birth removed to Kentucky, where young Meek received a common school education, and was known when quite young for his ability as a writer, his retiring disposition, and for exhibiting a marked interest in geology and kindred branches of science. On arriving at his majority he entered into commercial pursuits in which he was not successful, and afterward for a time earned his daily bread as a painter of portraits and such other subjects as the necessities of his surroundings offered to him. He was also connected for a time with some local museum of curiosities of the old-fashioned kind. At a later date his geological predilections were favored by a connection with some of the earlier geological surveys in the West, while his scientific career may be said to have fairly been opened by his employment as a draughtsman and assistant on the survey of the State of New York. The discovery which first brought him into prominence was his identification, independently, of Peruvian rocks in America, a fact which was discovered nearly simultaneously by several better-known geologists. His undivided attention to palæontology and his almost unrivaled abilities in delineating the fossils which he studied, joined to great caution and what appeared to be an intuitive capacity for recognizing the relations of the remains he described, soon placed him in the front rank of American palæontologists. The progress of geological discovery in the West, which has culminated at the present day in the great surveys of Hayden, Powell, and Wheeler, under government auspices, is in large part due to the abilities of Mr. Meek, for without

such able coöperation the fossils of the different strata, of which by far the greater proportion were determined by him, would have failed to yield a moiety of the material for generalization upon which American geology has been built up. Among numerous publications on American palæontology by the deceased may be mentioned the Invertebrate Palæontology of Illinois, Ohio, part of California, in the Geological Survey Reports of these States; an Early Report on the Palæontology of the Upper Missouri, published by the Smithsonian Institution; on the Palæontology of the Explorations under Simpson, Macomb, King, and other Government Surveys and lastly the great work of his life, the Palæontology of the Upper Missouri, just issued by Dr. Hayden in the quarto series of the publications of the Geological Survey of the Territories. In all these volumes the palæontological work was strictly his own, though his name was for sufficient reasons associated with that of the geologist, to whom the collections were due or under whose direction the publications were issued.

Mr. Meek left no kindred so far as is known. His habits were most simple and regular, abstinent to a remarkable degree, and he shrank from society, except that of a scientific character or of a few old and valued friends. This retiring disposition was encouraged by the infirmity of total deafness by which he was afflicted during later years and which he bore with the utmost patience. Only a few intimates could know of his cheerful, helpful spirit, his love of children and animals, his transparent honesty and probity, and the generosity which led him to render assistance to the beginner or the practiced geologist whenever his help was requested. His death resulted from the weakness consequent on pulmonary hæmorrhage from which he had suffered for some years. His illness was painless and of short duration, and his remains were carried from the geological hall of the Institution he had served so long to the Congressional Cemetery in Washington, by a small but appreciative assemblage of his associates and friends. — W. H. Dall.

— The Summer School of Biology at the Peabody Academy of Science, Salem, Mass., met with such a good measure of success last year that it will be a permanent feature of the work done at the Academy. Though the school was limited to fifteen, more than this number were present. Over forty lectures were delivered. The laboratory work done was in some cases excellent. The school is designed to give laboratory facilities to naturalists and teachers residing in inland towns who may like to spend their summer vacations in collecting and studying marine life at the seaside.

— Professor Valerien de Moeller, of the Imperial School of Mines, St. Petersburg, Russia, is preparing a monograph of the *Fusulerias*, and desires any information on the subject that he can obtain from American palæontologists.

— Prof. L. de Koninck, the veteran palæontologist, of Liége, Belgium,

has commenced his great work on the Carboniferous fossils of Belgium, to contain 150 plates, 4to. After forty-five years of service the Belgian government has conferred upon him a pension, which will enable him to spend the remainder of his life in comparative independence.

— The Congrès International des Américanistes will hold its second session at Luxembourg, September 10–13, 1877. The secretary, Mr. J. Schoetter, is very anxious that communications be sent at as early a date as practicable from Americans. He hopes that American savants will be induced to take as large a part as possible in this meeting, and that they will furnish matter enough for one volume of the *Comptes rendus.*

— Karl Ernst von Baer, the eminent zoölogist and embryologist, died at St. Petersburg, November 29, 1876, aged eighty-five years. He will always be remembered for his classic work, Ueber Entwickelungsgeschichte der Thiere, 1828–37. In 1834 he resigned his chair of zoölogy at Königsberg and removed to St. Petersburg, becoming librarian of the Academy of Sciences. — Theodor von Heuglin, the traveler and zoölogist, died at Stuttgart, November 5th, aged fifty-two years. — A well-known Scotch zoölogist, Dr. T. Strethill Wright, died October last, aged fifty-eight.

— In order to furnish an opportunity for teachers in natural science and special students in geology to become acquainted with the methods of practical work in that science, a Summer School of Geology will be conducted by Prof. N. S. Shaler and Mr. Wm. M. Davis, Jr., assistant in geology, during six weeks in July and August, under the form of instruction at Cambridge and an excursion through Massachusetts and into New York. The school will open early in July at the Museum of Comparative Zoölogy, in Cambridge. A fortnight will be spent in introductory work, and in short, daily excursions. The rest of the time will be divided between the Connecticut Valley, the Berkshire Hills (Western Massachusetts), and either the Helderberg or the Catskill Mountains of New York. In each locality some central point, characteristic of the district and easily accessible by railroad, will be taken for headquarters, and short excursions on foot or by rail will be made from it. Persons wishing to join the school should address Wm. M. Davis, Jr., 15 Summer St., Cambridge, Mass.

— Professor Henry urges the establishment of a national museum at Washington, with the government Centennial collection as a nucleus, and the repaid Centennial loan as a building and endowment fund.

PROCEEDINGS OF SOCIETIES.

New York Academy of Sciences. — *Biological Section*, October 2d. Captain J. H. Mortimer exhibited a series of pelagic animals, such as pteropods, Carinaria, Atlanta, Janthina, small cephalopods, crustacea, and the insect *Halobatis*, together with Salpa, Physalia, Porpita, Vellela,

etc., collected by him in the course of a voyage from New York to San Francisco, and back by way of Liverpool.

Geological Section, October 16th. A paper on Prehistoric Remains in Western North Carolina was read by Mr. A. A. Julien, who has been associated with Professor Kerr in the survey of that State. Four classes of such remains were considered, namely, tools, rude sculpturings, mounds, and excavations. A small collection of tools was exhibited, and accidental resemblances to those from St. Acheul, France, noted in them. The rude imitative carvings on rocks, which have been observed in two localities, were then referred to, as well as those, possibly of Indian origin, on beeches in the Nantehaleh Valley, resembling maps of the surrounding excavations. The scarcity of mounds was explained, their general restriction to the tract covered by ancient excavations referred to, and a description given of the largest one, near Franklin, Macon County.

A remarkable pitting of the mountain sides by mines is now going on; but perhaps it hardly equals that which formerly existed, as represented by the extensive series of ancient excavations which extends from Mitchell County southward to the state line, and into Georgia, and which seems to have been directed to the exploitation of two minerals, muscovite and steatite. The peculiar industry of the region at present consists in mining for mica. The coarse granite veins which contain it often include a central quartz band, which has affected the character of both the prehistoric and the present styles of mining. All the mines are superficial, and their veins may be divided into hard or soft, in relation to the state of decomposition of their materials. In fourteen mines visited, in which the veins are hard, no ancient workings had been found. But of twenty-one mines with soft veins visited, eight had been discovered through the ancient workings, whose size was proportioned to that of the veins, and generally indicated their importance for the present industry. These workings are of two classes. The one consists of deep shafts, sometimes containing iron tools, and supposed by some to be due to the Spaniards, or to later adventurers in the early history of our country. The other class consists of open excavations, sometimes connected with small tunnels, and are certainly of prehistoric origin. These were severally described, namely, the Sink Hole and Buckhannon mines in Mitchell County; the Gibbs in Yancy County; Allman's, Raby's, Hall's, and Smith's in Macon County; and Smith's in Clay County, with observations on the mode of mining, the form of the tunnels, the character of the dumps, the plans and sections of the excavations, and the tools probably used by the ancient miners. The ashes discovered in certain mines may betoken the occasional use of fire in the course of mining here, as in the tunnels of the Lake Superior copper region.

The vast quantities of mica which have been extracted in this region

in prehistoric times were then considered, and their probable destination. Lastly, a description was given of the similar, but less extensive, series of excavations for steatite in the counties of Clay, Swain, etc. The importance of a careful topographical survey of this portion of the State should be impressed, upon its people and their legislators; but unless it speedily takes place the progress of agriculture and the absence of public interest will soon destroy many of these interesting monuments of its ancient history.

The paper of Mr. Julien was discussed with much interest. Dr. Newberry and Professor Martin referred particularly to the extensive use of mica plates in the tombs of the mound-builders in the Mississippi Valley, as described by Dr. Rau in his essay on aboriginal trade in North America. It is evident that in these mines we have the source of this mica, which had until recently been a problem with archæologists.

Prof. Thomas Egleston read a paper upon Vein Accidents in the Lake Superior Region; its character was such, however, that it is difficult to present it without the diagrams which accompanied it.

The Biological Section held a special meeting on October 30th, at the library of the New York Aquarium. The chairman of the section, Prof. E. C. H. Day, gave an opening address entitled Thoughts on Evolution, in which he opposed a good many objections that are raised against the evolution hypothesis, and pointed out their weakness. President Newberry followed, in a somewhat different view, holding that many of these objections are yet unanswered. Mr. Frederick Mather, of the aquarium, then described and illustrated quite fully the operations now going on there in the hatching of the California salmon, with which it is proposed to stock the Hudson River.

Section of Geology and Mineralogy, November 20th. Papers on the Smelting of Native Copper at Lake Superior, by Prof. T. Egleston; on New American Fossil Fishes, by Prof. J. S. Newberry; and on the Lower Helderberg Rocks at Port Jervis, N. Y., by Dr. S. T. Barrett, were read.

PHILOSOPHICAL SOCIETY OF WASHINGTON. — November 18, 1876. Dr. E. Bessels spoke of the English Polar Expedition, calling attention to the fact that the season they experienced was an evidently abnormal one, as compared with the experiences of all other observers; and that while it was doubtless true that under the circumstances no great progress toward the pole was possible, yet the obstacles encountered by these energetic explorers were by no means proved to be permanent, or insuperable in more favorable seasons.

He called attention to the confirmation by the English of the observations made by him during the Polaris expedition, showing that the tides in the northern part of the channel come from the north; not (as he had at one time supposed) from the Pacific, but from the North Atlantic around the north coast of Greenland.

Mr. Dall remarked that the difference in character of the tides in the West Arctic basin, in Bering Sea, and in the North Pacific south of Bering Sea was such as almost to render certain the fact that the basin of the Polar Sea west of the Parry Islands has a tide of its own, which, according to Haughton (On Tides at Point Barrow), is a simple semi-diurnal wave, totally different from those observed by the United States Coast Survey in the other localities mentioned. He indorsed Dr. Bessels' view that the northern tides of Polaris Bay were in all probability derived from the North Atlantic.

December 2, 1876. Colonel Mallory, United States Army, exhibited a painted cloth which was obtained from a Sioux Indian, and which was a second copy from the original, said to have been prepared by Lone Dog, a Sioux, who was stated to be the official chronicler of the Sioux tribes of the Northwest. This cloth contained a series of symbols placed in sequence so as to form a spiral beginning at the middle of the cloth and extending from left to right. These symbols were seventy-one in number, and were said to form a chronology of events, one for each year, beginning with the year 1801 and including 1871. The events were not of an important character in all cases, but were such as were probably specially notorious at the time of occurrence, therefore easily remembered and suitable for forming such a chronology. They did not relate solely to the chronicler's own tribe, but to the Sioux tribes in general. The events were frequently of an apparently trivial character, such as a particular murder or successful theft of horses, fight with the Crows, or building of a trading post; sometimes of more importance, such as an eclipse of the sun, the prevalence of a pestilence, the appearance of the first soldiers, etc. Colonel Mallory explained the asserted meaning of the symbols as obtained from a large number of Sioux of different tribes, independently, at different times and places, all of whom were said to recognize the chronological character of the inscription and the meaning of part of the symbols, though none were able to explain all of the latter. Yet by the explanations of different persons, most of the signs were explained. All were agreed as to the authorship and nature of the chronology, and their explanations were not paid for, hence a strong probability of the authenticity of the chronology and of its really chronological character.

Much discussion followed on the reading of the paper. It was pointed out by Major Powell and others that while the figures were many of them unmistakably Indian in their character, yet the commencement of the record with the century, the representation of an eclipse as a black sun instead of by the mythological symbols, the representation of individuals by symbols drawn from the literal meaning of their names instead of by their totemic symbols, were not aboriginal characteristics, and tended to throw a doubt on the purely Indian character of the author or inspirer of the record, which nevertheless possessed great inter-

est. The general verdict appeared to be that further confirmation of the character and original authorship of the asserted chronology was much to be desired.

BOSTON SOCIETY OF NATURAL HISTORY. — November 1st. Prof. A. Hyatt made a communication on sponges, discussing their mode of development, based on original observations, and expressing his opinion that they formed the type of a new sub-kingdom of animals. Mr. J. A. Allen remarked on the American beavers, recent and fossil.

November 15th. Two papers were read by C. S. Minot entitled Classification of some of the Lower Worms; Description of a New Microtome for Cutting a Series of Sections.

December 6th. Prof. W. G. Farlow gave an account of certain algæ belonging to the groups *Oscillatoria* and *Bacteria*.

December 20th. Prof. C. H. Hitchcock and Rev. G. F. Wright spoke on ancient glacial moraines in Andover, Mass., and vicinity.

SCIENTIFIC SERIALS.[1]

PETERMANN'S GEOGRAPHISCHER MITTHEILUNGEN. — October 28th. Die neuen administrativen Eintheilungen Japans, von L. Metschnikoff. Bilder aus dem hohen Norden, von K. Weyprecht. Lieut. Wheeler's Expedition durch das südliche Californien im Jahre 1875, von O. Loew. Die Temperatur-Verhältnisse im Meere zwischen Norwegen, Schottland, Island, und Spitzbergen, von H. Mohn. October 9th. Die Insel Hawaii und ihre Vulkane, von F. Birgham. Die geographische Verbreitung des Hagels, von H. Fritz. Die jüngsten Forschungen im See-'ngebiet des äquatorialen Ost-Afrika, von Young, Gessi, Stanley, 1874–76. Reisen in Columbien im 1872.

ARCHIV FÜR NATURGESCHICHTE. — 42. Heft ii. Ueber einige Canis-Arten des südlichen Südamerika's, von H. Burmeister. Ueber die Nahrung der *Alausa vulgaris*, und die Spermatophore von *Temora velox* Lilj., von Max Weber. Die Familie der Bdelliden, von Dr. Kramer. Die Hautdecker und Schale der Gastropoden, von F. Leydig. Heft iii. Anatomisches und histiologisches ueber Gibocellum, eine neue Arachnide, von A. Stecker.

THE GEOGRAPHICAL MAGAZINE. — December. Hissar and Kulab (Turkistan). The Indian Surveys, 1873–75.

THE GEOLOGICAL MAGAZINE — December. On the Glauconite Granules of the Cambridge Green Sand, by W. J. Sollas. On Fossils from the Glacial Deposits of the Island of Lewis, by R. Etheridge. Fossiliferous Pliocene Clays overlying Basalt in Lough Neagh, by E. T. Hardman.

[1] The articles enumerated under this head will be for the most part selected.

THE

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A FEW WORDS ABOUT SCAVENGERS.

BY PROF. SANBORN TENNEY.

IN most if not in all human societies there are classes, or at least individuals, who gain their chief subsistence by using or removing what others have ignored or discarded. That is, there are classes, or individuals, whose principal function seems to be that of scavengers.

(FIG. 16.) HYENA (HYENA VULGARIS.)

But scavengers are not confined to the human race. It is well known that as a general rule animals seek for their food living organisms or organic products in a good state of preservation. But there are in many of the classes of animals some kinds which prefer, or seem to prefer, to feed upon dead or decaying organisms. That is, there are animals whose chief function seems to be that of scavengers. Of some of these I will briefly speak.

Prominent among the mammalian scavengers are the hyenas (Figure 16), the ugliest in their general appearance of all the

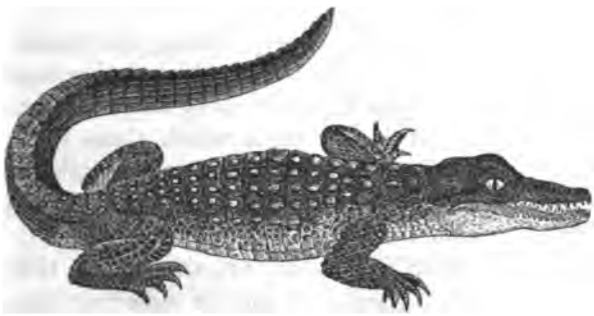
flesh eaters. These well-known animals are at present confined to the warm regions of Africa and Asia, where they feed upon animals which they find dead, and such parts of animals as have been left from the feasts of the lion, tiger, and others of the nobler kinds of the typical carnivora. The hyenas are about five feet in length, and are admirably fitted for their work as scavengers; for they not only devour the soft parts of animals, but their large, blunt premolar teeth and the powerful muscles

(FIG. 17.) CALIFORNIAN VULTURE (CATHARTES CALIFORNIANUS).

of their jaws enable them to crush and eat the bones of even very large animals; and thus these scavengers convert into their own living tissues not only parts, but the entire carcasses of animals that would otherwise taint the air and cause pestilence and death. This habit of the hyenas in preying upon dead animals is probably not one recently acquired. The members of this family that lived in Post-Tertiary times had essentially the same habits as have the hyenas of to-day, judging from their remains

and other evidences found in the cave deposits in England and in many other parts of Europe.

If we study the birds we find among them, also, some kinds whose office is that of scavengers. Rather than pursue and capture living prey, these prefer to feed upon dead animals, and upon these they gorge themselves, often eating far more than they need; and thus they too convert noxious substances into their own tissues. Preëminent among the bird-scavengers are



(FIG. 18.) ALLIGATOR (ALLIGATOR MISSISSIPPIENSIS).

the vultures (Figure 17), including the condor and others, which of all the flesh-eating birds are the least adapted for capturing living prey, and which by their bare heads and bare necks are the best fitted for feeding upon carrion, which forms so large a part of their food. It should be added here, however, that while vultures as a family are true scavengers, there is at least one species, the famous lammergeyer of the Alps, which has habits more like the typical rapacious birds. It not only captures lambs

(FIG. 19.) STURGEON (ACIPENSER OXYRHYNCHUS).

and other animals, but has the reputation of sometimes carrying off an infant child.

Reptiles, too, furnish us with examples of scavengers. Although many turtles, and the alligators (Figure 18), crocodiles, and gavials, are exceedingly rapacious, they are also among the prominent scavengers, eagerly feeding upon the dead animals which they find in the streams which they inhabit.

Nor are fishes without a representation of scavengers. Some kinds, as certain of the sharks, combine the most rapacious with scavenger characteristics. The sturgeons (Figure 19) are gen-

nine scavengers. With their long noses they turn up the bottoms of the streams and feed upon such organic materials as they chance to find, using perhaps the flexible feelers beneath the snout to search out the exact location and nature of the food.

The Catostomi, or "suckers," are essentially scavengers, although devouring also the weaker kinds of living animals. The same is true of the horn-pout and other species of cat-fish.

If we pass from the vertebrates to the articulates, we shall here find scavengers in every class. Among the insects, we may notice first the flies, some species of which are present to lay their eggs or deposit their larvæ in every animal as soon as it is dead. And how vast is the work which these little animals accomplish in transforming noxious substances into their own tissues. A single fly by means of her progeny can probably devour an ox quicker than can a hyena!

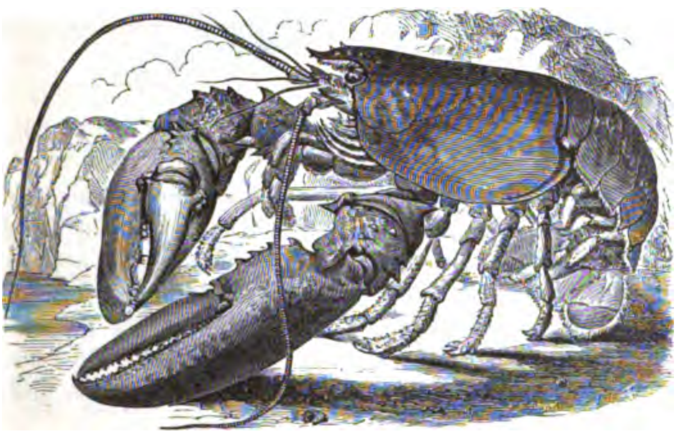
Mosquitoes in their larval state are also among the most important scavengers. They feed on the decaying organic substances which abound in the stagnant waters everywhere, and thus they help to remove the fruitful sources of malaria. Therefore we may put this fact down to their credit when we lie awake in the summer night, defending ourselves against the attacks of these pests in their adult state.

How many of the eighty or one hundred thousand species of beetles are scavengers, we may perhaps never know. But that there are many beetle scavengers we well know; and all are aware how constantly the common carrion beetles (*Silpha*, Figure 20) are engaged in the work so important to the higher animals and to man. No sooner is a dead animal thrown upon the ground and decay begins, than these beetles commence their work of rendering it harmless. Some species of carrion beetles have the habit of burying all the small animals which they find,—and they find out with astonishing quickness where such animals are. They bury animals by constantly digging beneath them; and when they have sunk them into the ground, out of sight, the females lay their eggs in them, so that when the young hatch they find themselves in the midst of suitable food.

(Fig. 20.)
CARRION BEETLE (SILPHA).

Among the Myriapods there are also some species which are scavengers. This is true of the well-known galley-worm (*Iulus*) found under rubbish and which quickly coils up when disturbed.

It is not pleasant for the epicure to learn that the lobster (Figure 21) is essentially a scavenger; but in a list of scavengers this and other crustaceans, notwithstanding their exhibition of true predaceous habits, cannot be omitted. They eagerly feed upon the dead organic materials which they find at the bottom of the ocean. The lobster fishermen well understand the scavenger habits of these crustaceans, and accordingly bait their lobster traps with pieces of fishes and of other animals, and then sink them to the bottom. What a wonderful chemistry these animals must possess to enable them to convert refuse animal matter into the delicious white muscle which most of us relish so much! And here it may be remarked that crustaceans are among the few scavengers whose flesh is prized for food by man.



(FIG. 21.) AMERICAN LOBSTER (HOMARUS AMERICANUS).

Most scavengers are of benefit to man only by aiding in keeping the air and the waters pure.

The mollusks have their scavengers. The strombs, whose heavy broad-lipped and deeply notched shells (Figure 22) are familiar objects in all of our museums, are prominent examples. The strombs are reckoned among the carnivorous gasteropods, but they are carnivorous in the same sense as are the vultures among birds, — they are carrion-eaters. And in this same category belong the slugs (*Limax*), and others.

Clams, oysters, mussels, etc. (Figure 23), are to a certain extent scavengers. They feed upon whatever organic particles are brought to the mouth by the vibratile cilia of the gills. It is thus, in part, that these mollusks remove the fine particles from turbid and impure waters and ultimately render them clear.

I hasten to say, however, that bivalve mollusks do not feed wholly and probably not mainly on decaying organic particles. The currents of water, alluded to above, bear also all kinds of microscopic plants and animals which abound in the water where these bivalves live.

To what extent radiates and protozoans are represented by scavengers I am not now prepared to state, but reasoning from

(FIG. 22.) STROMB (STROMBUS PUGILIS).

(FIG. 23.) FRESH WATER MUSSEL (UNIO COMPLANATUS).

what we see in the other branches of the animal kingdom, we may at least suppose that there are true scavengers in these lowest branches also; and that their structure and appearance are perhaps as remarkable as are found in the higher forms.

And is there not something remarkable in the general appearance of scavengers as well as in their habits? Does not the hyena present a marked appearance among mammals, and the vulture among birds?

The facts about scavengers suggest many interesting questions. Why are there scavengers at all? Especially why are there scavengers in localities and regions where living animal food is apparently in great abundance? What is their origin? Have they existed from the beginning of animal life on the globe? When did the first individuals begin to appear in the various groups? Is their structure the result of their habits, or have their habits determined their structure?

The facts about scavengers are well known to all naturalists; and they are facts, without doubt, of deep significance. But I am not aware that the existence of scavengers has been explained in accordance with the modern views in biology.

It may possibly be replied that there is nothing specially remarkable in the existence of scavengers, when viewed in the light of the doctrines of natural selection. There is but little

doubt that the masters in modern biological thought have a ready answer to all or most of the questions which naturally arise in a thinking mind while considering the existence of scavengers among animals. Is not the subject worthy of their further attention, and may we not have the pleasure of reading their views in the Naturalist?

ON A PROVISIONAL HYPOTHESIS OF SALTATORY EVOLUTION.

BY W. H. DALL.

IT has long been brought forward, as against the Evolutionary Theory, that there were missing links in the chain of development which could not fairly be charged to the account of deficiencies in the palæontological record. This is the chief weapon of all opponents to the doctrines so generally received by modern naturalists. The number of instances in which the objection is well founded has been much exaggerated, but that there are cases of the kind will not, I think, be denied by any impartial student, though some imprudent partisans of the new faith have rather scoffed at the idea.

Having confidence that evolution when fully understood in all its modes will prove amply sufficient to account for all phases of organization, and realizing that leaps, gaps, saltations, or whatever they may be called, do occur, I have for some years made this branch of the subject a matter of reflection in the hope of arriving at some clew to the mode.

I have had my attention more especially called to the matter in studying a phase of the kind of evolution I have here termed *saltatory*, which is especially referred to in Cope's paper on the Origin of Genera, where, if I recollect rightly, it finds expression in the paradox that "the same species may belong to two different genera."[1] That is, more explicitly, that species which are abundantly proved to be distinct from each other by generic characteristics may be, so far as their specific characters are concerned, not distinguishable from one another. Such cases are mentioned by Cope in the paper alluded to, and there are other well-known instances of the paradox among birds, Crustacea, and Brachiopoda.

(1.) As an illustration of how the apparent leaps, which

[1] Not having seen Professor Cope's paper since about the time of its publication, and a copy not being accessible to me at this time, I may not have quoted the exact words, but the idea is the same.

nature occasionally exhibits, may still be perfectly in accordance with the view that all change is by minute differences gradually accumulated in response to the environment, I would offer the following example: —

In any sloping gutter of a paved street not too cleanly swept, every one will have noticed during a sudden shower how small particles of earth and other materials will sometimes act as a dam, producing a puddle which, relieved by partial drainage, may for a time appear to remain *in statu quo*. A time comes, however, when the gradually accumulated pressure suddenly sweeps the dam before it for a short distance. Then another similar pool is formed, and so on indefinitely.

(2.) The modern idea of a species may be stated to be *a greater or lesser number of similar individual organisms in which for the time being the majority of characters are in a condition of more or less stable equilibrium; and which have the power to transmit these characters to their progeny with a tendency to maintain this equilibrium.*

(3.) This tendency may be in some cases sufficiently strong to resist for a considerable period the changes which a gradual modification of the environment may tend to bring about. When the latter has reached a pitch which renders the resistance no longer effectual, it is conceivable that a sudden change may take place in the constitution of the organism, rapidly adapting it once more to its surroundings, upon which the tendency to equilibrium may reassert itself in the minor characteristics, and these may, as it were, crystallize once more in a manner not dissimilar in its results to the form which was recognizable in the earlier generic type.

(4.) If among a certain assemblage of individuals forming a species the tendency to maintain the specific equilibrium is (as it should be, *a priori*) transmitted to individual offspring in different degrees of intensity, a gradual separation may take place between those with the stronger tendency to equilibrium, and those with less.

(5.) Those yielding to the pressure of the environment (let us say in the manner indicated in paragraph 3) must by the law of natural selection become better adapted to it, and with their changed generic structure may be able to persist.

(6.) On the other hand, those with the broader base, so to speak, with an inherited tendency to remain unshaken by the modifications of the environment, may be conceived as being and

remaining, through this tendency, less injuriously affected by *adverse* circumstances and consequently might still endure.

(7.) In short, natural selection in the one case might find its fulcrum in the easy adjustment of characters; and in the other case in the inherited persistency in equilibrium, by which the organism would be rendered more or less indifferent to the injurious elements of the environment as well as to its favorable phases.

(8.) The intermediate individuals, by the hypothesis, would be those least fitted to persist in any case, and therefore would be few in number and rapidly eliminated. Then we should have a parallel series of species in two or even more genera, existing simultaneously.

(9.) The above hypothesis would account for the special class coming under the paradox quoted, and has an important bearing on the interpretation of certain embryological changes. For other forms of Saltatory Evolution attention should be directed to the inherited tendency to equilibrium which is the converse of the inherited tendency to vary, but which has hardly been granted the place in the history of evolution to which its importance entitles it. Mr. Darwin, whom nothing escapes, has apparently recognized it in his testimony to the "remarkably inflexible organization" of the goose. Other writers seem to have been chiefly attracted by the converse of this tendency, as, under the circumstances, is most natural.

It seems as if the preceding reasoning might serve as a key to many puzzling facts in nature, and perhaps deprive the catastrophists of their most serviceable weapon.

HINTS ON THE ORIGIN OF THE FLORA AND FAUNA OF THE FLORIDA KEYS.

BY L. F. DE POURTALES.

DURING several seasons passed on or near the Florida reefs and keys, engaged in sounding and dredging in the Gulf Stream, in the service of the United States Coast Survey, I had occasion to make a few observations on the vegetable and animal inhabitants of the islands. They were of course made without system, only in such places where the steamer happened to be in stormy weather, and I have been obliged to complete them as much as possible by the observations of others. Incomplete as they still are, they are given in the hope of drawing the atten-

tion of future visitors to this interesting region to several points in the mode of introduction of plants and animals into a new region, worthy of more extended study.

We have here a curious example, on a very small scale to be sure, of land of comparatively recent origin, which has received its flora and fauna from two different and very distinct sources, the West Indies and the North American Continent, and, as it seems, the flora chiefly from the former, the fauna mostly from the latter.

For a proper understanding of the subject I must refer to the description of the Florida keys and reefs, by Professor Agassiz, in the Coast Survey Report for 1851 (it was never published *in extenso*), and in his Methods of Study; also to an able paper on the same subject, by the late Lieut. E. B. Hunt, of the United States Engineers, in the Coast Survey Report for 1862, and the *American Journal of Science*, vol. xxxv.

Lieutenant Hunt expresses the opinion that the reefs and keys shoot out as it were by their western end into the deep waters of the Gulf of Mexico. He says, "The well-traced curve along which this grand Florida bank thrusts itself out into the deep waters of the gulf is strikingly significant of some continuous and regular agency in its production. The adjacent flow of the Gulf Stream would most naturally be assumed to govern in some way the production of this curve. It however runs in the contrary direction to serve this explanatory use, and it is in fact rarely found to run close in upon the reef. There is, however, an eddy, countercurrent, intermitting in character and of variable rate, but on the whole a positive and prevailing current." We have not, unfortunately, observations enough of the currents near the reef to confirm these remarks otherwise than by a few scattered and often contrary ones, but judging by the effects, the above statement is undoubtedly true, and theoretically we should expect to find a countercurrent in the concave side of a bend of the main current. To the effect of this eddy ought to be added the still more regular westward action of the trade-wind and the flood tide. The formation of new islands and the westward extension of the reef are, however, probably of more than secular slowness, and the first discoverers of what was then called The Martyrs found them very nearly as we see them now. We may even have to record periods of retrogression as we do in glaciers, when a period of exceptionally frequent or violent hurricanes destroys more than the growth of corals and the piling up of their *débris* can supply.

Thus in the past forty years, Looe Key, part of Sand Key, and North Key, at the Tortugas, have been swept off and replaced by shoals.

The actual western termination of the system of keys is at Loggerhead Key, one of the Tortugas, but shoal ground extends some twenty miles farther west. The reef proper terminates opposite the Marquesas, about forty miles east of the Tortugas. The ancient reef which preceded the one which formed the keys did not extend as far west by more than one hundred miles, terminating about Cape Sable.[1]

The formation of the keys to the westward of Key West plainly shows their more recent origin. The Tortugas consist mostly of coarse coral sand, sometimes unconsolidated, sometimes, as at Loggerhead Key, forming a soft rock, quite different from the harder limestone of Key West. At Loggerhead its very recent origin is plainly seen by its containing occasionally pieces of metal from wrecks, such as bolts, nuts, nails, etc. East Key of the same group seems to be washing away at its southern end and forming anew at the north. North Key, which has been mentioned as having disappeared, is said to have had the only well of fresh water in the group. It was explained by my informant, probably correctly, as having been composed of very fine sand, more apt to retain the rain-water unmixed than the coarser sand of the other keys.

The marine fauna of the coral region of South Florida is a West Indian colony engrafted on the more or less North American fauna of the east and west coasts of the peninsula. From Cape Florida and from Cape Sable northward the reef corals and their commensals are not found, the calcareous is replaced by silicious sand, oyster banks fill the bays, and a great change is apparent by a mere look at the prevailing shells thrown up on the beaches.

The flora of the keys is very largely West Indian in its origin. Mr. Frederick Brendel has given in vol. viii. No. 8, of this journal, interesting remarks on the species of plants common to

[1] I would urge on the winter excursionists to that part of our country the exploration of the region of the Everglades, northwest of the Miami River, with regard to the number and distances of ancient reefs, which ought to assume the form of rocky islands in the marshes. Long Key in the Everglades, by its shape and parallelism to the known ancient reefs, must be of that character, and there are probably more. The fossil corals found in them would be of interest to compare with more recent ones. It would be desirable to know also how far north of Cape Florida coral rock extends along the coast. I take this opportunity to say that the Museum of Comparative Zoölogy in Cambridge would be thankful for a set of the fossil corals of Tampa Bay.

South Florida, the West Indies, and Mexico, to which I refer the reader. I would only state that the anomaly noticed by Mr. Brendel in the number of species common to South Florida and Mexico being so much smaller than those common to the former and the West Indies can hardly be explained by a former connection of the land as he seems to imply. The distribution of animals, as we shall see, would not bear out this theory.

No botanist, as far as I can find, has made a discrimination between the flora of the keys proper and that of the mainland of South Florida; it would no doubt show that some of the few plants common to Northern and Southern Florida do not extend to the islands; the pine is a conspicuous example, its growth being apparently incompatible with pure calcareous soil; the Pine Keys, back of the main range, are the only ones bearing a growth of pines, and they have silicious sand, as I was informed by Professor Agassiz. I have often regretted not having visited them. Seen from the middle of Key Biscayne Bay the difference between the mainland and the keys is quite conspicuous. The border of mangroves is of course the same on both sides, but above it on the former the horizon is closed by the pine forest so characteristic of the shores of the Southern States, while on the latter the larger trees are fig-trees of two or three species, the quassia (*Simaruba*), the torchwood (*Bursera*), the mahogany, and a few others, interspersed with a dense shrubbery, in which several species of *Eugenia* are perhaps the most common and characteristic. Near the water the *Coccoloba*, or sea-grape, forms conspicuous groups, and on muddy shores the mangrove and the *Avicennia*, called locally the black mangrove, are always ready to consolidate the new-made land, the former by its air roots and numerous floating fruits, the latter by its creeping roots. In sandy places the palmetto seems to monopolize the ground, but never rises to more than ten or fifteen feet.

The tree vegetation seems to be most luxuriant, comparatively speaking, about the central part of the chain of keys, say from Key Largo to Key West. At Key West it has an appearance of decline, though it is hardly a fair point of comparison, as most of the trees suitable for fire-wood have been destroyed and many trees and plants introduced which have changed the aspect of the vegetation. West of this, however, the change becomes more marked, until finally we reach the Tortugas, where I made it a point to try to collect every plant growing on the group. I think I nearly succeeded, and obtained only fourteen species, which my

friend, Mr. Lesquereux, had the kindness to determine for me. They are *Suriana maritima*, the largest shrub covering most of the islands, improperly called bay-cedar by the inhabitants; *Tournefortia gnaphalioides; Avicennia tomentosa*, a few crippled specimens on Bush Key, and also growing on the parade ground of Fort Jefferson; *Scævola Plumieri; Euphorbia glabella*, *Cordia bullata*, probably introduced near the light-house; *Ambrosia crithmifolia; Nasturtium tanacetifolium; Battatas littoralis;* a large *Opuntia*, probably introduced; an undetermined *Labiate; Cenchrus tribuloides; Cyperus microdontus* and *Eragrostis macrantha.*

This scarcity of plants may be attributed to various causes, but the principal one is no doubt the more recent formation of these islands, more imperfect consolidation, and the as yet insufficient accumulation of vegetable soil. The distribution of seeds may also be influenced by the currents in such a way as to be left in greater numbers on the keys farther east, which would be first touched by the eddy currents of the Gulf Stream; but this question I would only touch upon under great reserve.

It would be an interesting study for a resident botanist to collect the numerous seeds thrown on the beaches of Florida and test their germinative powers. Some kinds seem to germinate, but still not to grow up to maturity. Thus I have seen the cocoanut germinating among the rubbish thrown up by the sea, but do not recollect seeing a tree grown up under such circumstances, although it does well under cultivation. Among the most common and conspicuous seeds found on the beaches are the large beans of *Entada gigalobium*, so well protected by their hard skin that they stand transportation by the Gulf Stream as far as Spitzbergen. Yet they do not germinate in Florida, so far as I know.

The land animals, as has been stated, are mostly immigrants from the mainland, with some exceptions which will be noted. The few mammals are entirely North American, and it is interesting to note how far the different species have penetrated along the chain of islands. For much of this informatian I am indebted to Colonel Patterson, one of the oldest residents of Key West, and a keen sportsman in his younger days. The deer and the raccoon have wandered as far as Key West; beyond this no mammals are found. The deer is probably destroyed at present, but the raccoon is still not uncommon. There may be a small rodent in addition, and perhaps the aquatic rabbit of the Southern

States. The bear does not extend so far — I think only to Matacumbe — and is probably only a visitor at the time when the turtles lay their eggs, of which he is said to be very fond; there would be little food for him at other times. Key Largo which is connected by a narrow isthmus with the mainland has the mammals of the latter, opossums, squirrels, etc. A burrowing rabbit, according to Colonel Patterson, is found on Rabbit Key, a very small and isolated islet in the bay or sound between the mainland and the keys. To reach Key West from Key Largo, some fifteen or more channels (some of them three or four miles wide) have to be crossed in passing from island to island. The want of fresh water is the probable inducement for the undertaking.[1] The absence of North American mammals from Cuba and the Bahamas would seem to give a great antiquity to the present course of the Gulf Stream which has proved an impassable barrier.

Of birds little can be said on account of their wandering habits. After hurricanes, birds from Cuba are often taken here, which are not seen at other times. A list of the regular breeding birds would be interesting.

For the batrachia and reptiles I can only give a list for Key West, kindly made up for me by Mr. Garman from the collection in the Museum of Comparative Zoölogy. The batrachia are *Hyla cinerea* and *Scaphiopus solitarius;* the snakes, *Tropidonotus compressicaudus*, *Coryphodon constrictor* (Tortugas), *Elaphis obsoletus* and *guttatus*, *Liopeltis æstivus*, *Crotalus adamanteus;* the saurians, *Plestiodon quinquelineatum*, *Cnemidophorus sexlineatus*, *Anolis principalis*, and *Sphærodactylus notatus*. The chelonians are represented by *Thyrosternum Pennsylvanicum;* the salt-water terrapin is said to be found at the Marquesas, between Key West and the Tortugas, but I have never seen a specimen.

All of these, with the exception of *Sphærodactylus*, from Cuba, are North American species. The batrachia are said by Wallace to be very seldom represented in insular faunæ, being rapidly killed by salt water. The two species mentioned above may have been transported with soil from the mainland, which has been sometimes brought to enrich the gardens.

Of the insects I cannot speak. There will be probably found here a considerable mixture of North American, Cuban, and

[1] While on the subject of mammals I would mention that a very imperfectly known West Indian seal is found occasionally in numbers on the Dog rocks, northeast corner of Salt Key Bank, about one hundred miles from Key West.

Bahamian forms, as the distances are not too great to be traversed by most flying insects. It would be an interesting study for an entomologist to find out how far North American species have adapted themselves to the West Indian flora, and how far they have varied under this influence.

With regard to the land shells, I am enabled by the kindness of Mr. Thomas Bland, to give more extended lists than in the other departments. Mr. Bland, not content to give me the benefit of his own large stock of knowledge, has spared no pains to gather all the information within reach, principally from Mr. W. G. Binney and Mr. W. W. Calkins.

Mr. Binney remarks that the fauna of the keys is quite the same as that of the mainland from Tampa Bay to the Miami River, and that this fauna is about equally derived from the great "Southern Province" of the eastern region of North America and from the West Indies, and gives the following lists in corroboration: —

Species certainly derived from the "Southern Region" of North America, not from West Indies.	West Indian Species found in Florida.
Glandina truncata, everywhere.	Zonites Gundlachi, Key West.
Succinea campestris, Key West.	Patula vortex, mainland and keys.
Polygyra Carpenteriana, Key West, Key Biscayne.	Helix varians, Key West to Key Biscayne.
Polygyra septemvolva, Key West.	Cylindrella Poeyana, Miami River, Key West.
" cereolus, "	Macroceranus pontificus,[1] Miami River to Tampa.
" uvulifera, "	Macroceranus Gossei, Little Sarasota Bay.
Pupa variolosa, "	Bulimus marietinus, Miami River.
" modica, "	Strophia incana, mainland and keys.
" rupicola, "	Stenogyra octonoides, Miami River.
Helix pulchella, "	Stenogyra gracillima, Miami River, Key West.
Zonites minusculus, "	Lignus fasciatus, Miami River, Key West.
Helicina orbiculata, "	Orthalicus undatus, " "
	Chondropoma dentatum, Miami River, Key West.
	Cylindrella jejuna, Miami River, Key West.

From Mr. Calkins' list I add *P. incana* from Key West to Key Biscayne. That some species which are common to some of the West India Islands and to South Florida have had their origin in North America and spread from there, as stated by Mr. Binney, is a fact very difficult to account for. The currents are decidedly against it, and a former connection of the land not confirmed by a study of other classes.

We may recapitulate as follows from these notes, imperfect as

[1] Key West (Calkins).

they are: (1.) The vegetation of the Florida Keys is largely West Indian. (2.) The mammals are entirely North American, and no species common to Florida and West Indies, except perhaps some bats and the manatee,[1] which are not properly attached to the land. (3.) Reptiles and batrachia, North American with only one exception. The Cuban crocodile, lately discovered in South Florida, is never found on the keys. (4.) Land shells are about equally divided, with a slight preponderance of West Indian species.

On the whole, therefore, this small region is well entitled to be called a curious instance of intermingling of faunas, and worthy of being carefully studied in all its details, aside from the great interest it presents to the naturalist in its marine fauna and flora, and to the geologist as a working model of many of the agencies by which a large proportion of the sedimentary rocks have been formed.

A PROVISIONAL HYPOTHESIS OF PANGENESIS.[2]

BY W. K. BROOKS.

THE value of Darwin's Provisional Hypothesis of Pangenesis, as a legitimate attempt at a scientific interpretation of the facts of reproduction, is so evident that no apology for endeavoring to discuss the subject is necessary. I venture then to call attention to the following attempt to combine the hypotheses of Owen, Spencer, and Darwin in such a way as to escape the objections to which each is in itself liable, and at the same time to retain all that renders them valuable.

All characteristics which are fully established as peculiarities of the species are transmitted through the various forms of asexual reproduction, as well as by the ovum, which has in itself the power to develop, when excited by a proper stimulus which may or may not be the effect of impregnation, into a new individual of the parent form.

New characteristics, on the contrary, are transmitted through the agency of gemmules, which are thrown off by the cells implicated in the variation. These gemmules have not, like the ovum, power to develop into a new individual, but reproduce under

[1] The comparatively abundant fragments of manatee bones found by me in dredging off the Florida coast seem to indicate former migrations of that animal between Cuba and Florida. I believe it is not known now to leave the shores.

[2] Abstract of a paper read at the Buffalo meeting of the American Association for the Advancement of Science, August 23, 1876.

proper conditions the cell which formed them. They are stored up by the male gland and enter into its excretion, the seminal fluid, and are thus transmitted to the egg by impregnation. Since the body of the female is variable, like that of the male, some of the cells will occasionally form gemmules; some of these may be carried with the fluids of the body to the ovary, and thus gain access to an ovarian egg; but the female differs from the male in having no specialized organ for the aggregation and transmission of gemmules.

In this form the hypothesis demands only a very limited number of gemmules at any given time, since only those cells which are undergoing modification give rise to gemmules. We thus escape nearly all the difficulty of the Darwinian form of the hypothesis. We are also able to answer the objection raised by Galton, for the presence of great numbers of gemmules in the blood at any given time is not to be expected, and the testis and seminal receptacle are the only organs which normally contain any considerable number of them from the various parts of the body.

According to the new view we are to regard the male element as the originating and the female as the perpetuating factor in the reproductive process. The female is conservative, the male progressive. Adherence to type is brought about through the female, and adaptation to conditions through the male.

I will now give a more extended account of the manner in which gemmules are produced. An adult animal or plant is composed of cells which must be regarded as morphological individuals, for they exhibit all the properties which characterize an organism. They absorb nutriment, grow, give rise to formed material, and multiply asexually. These properties they can be proved to possess; we assume that they also have the power to give rise to eggs, or, to use Darwin's word, to gemmules capable of developing into similar cells. Assuming that this power, homologous with that of independent organisms, exists, let us see whether we can learn from the study of independent organisms the conditions under which it may be expected to manifest itself. We know that among animals and plants growth, development, and multiplication are so related that each can go on only at the expense of the others, and that anything which tends to check growth or development favors multiplication; we know too, that asexual and sexual multiplication are related in the same way. If the constituent cells of an organism are organisms in them-

selves, we should expect them to conform to the same laws. Most of the cells of the body are at any given time very perfectly adapted to the conditions under which they are placed, that is, such an adjustment has been brought about during the process of evolution of the organism, as to place each cell under such relations to its environment as are most favorable to the performance of its function in the body. This state of things will last until some unfavorable change takes place in the environment, either external or internal to the body. The adjustment between the cell thus affected and its conditions will of course be disturbed by the change, and if this change is great enough to check the performance of its normal functions, but not sufficiently great to destroy life, the cell will, after the analogy of other organisms, give birth to gemmules. As these gemmules when transmitted to the next generation are supposed to give rise to variations, we have a simple and consistent explanation of what is without doubt the greatest difficulty of the theory of natural selection: how, among the countless numbers of possible variations, a given cell ever happens to vary at the time change is needed. This explanation is all the more satisfactory since it simply embraces the unicellular organisms which compose the body under laws which are well established as applied to independent organisms. We can also understand why variations do not usually make their appearance in the individuals upon which the new conditions are first brought to bear, but in succeeding generations; for the new conditions do not result in direct variation, but in the production of gemmules which are transmitted to the next generation. It may perhaps be asked why a cell produced from a gemmule should be more variable than one produced by division. A cell formed by division commences its existence as a fully formed cell, but a gemmule has the absorption of food and the building of a body still before it, and it will therefore be more susceptible to external conditions, just as a house in process of construction is more easily altered than one which is finished.

If our assumption that newly acquired characteristics are transmitted by the male and those of long standing by the female is correct, the phenomena of crossing should furnish us with a test of the hypothesis. According to the theory of evolution, animals of allied species and varieties are the descendants of a common ancestor, and those characteristics which they have in common are due to this community of descent and are of long

standing, while those peculiarities which distinguish them from each other are in most cases of later origin. If, then, we make a reciprocal cross, that is, if we select two allied species or varieties and cross the male of one with the female of the other, and then reverse the process, using the female of the first and the male of the second, we should expect in most cases to find a difference in the offspring. Where the male of species A is crossed with the female of species B, we should expect the offspring to inherit from its mother the characteristics common to both parents, and from the father some of the distinctive marks of the species or variety A. In the second case we should expect it to unite some of the features of the form B to those peculiar to the genus. To take a special case; if we cross a stallion with a female ass we should expect, according to our hypothesis, to find that the offspring exhibited the characteristics of the Equidæ, together with some of the distinctive features of the horse, while we should expect to find that the offspring of the jackass and the mare united some of the specific features of the ass to those common to both parents. It is needless to say that this experiment has been tried thousands of times with a uniform result which agrees perfectly with the demands of our hypothesis. In some cases the result of reciprocal crosses seems to directly oppose our conclusions, but the difficulty is in many instances only apparent. A species sometimes differs from its allies, not in having acquired new characteristics, but by reversion or arrest, and such a species will transmit its distinctive features through the female rather than through the male. Thus the Niata cattle, which seem to be a reversion to an extinct form, are more prepotent over other varieties through the female than through the male.

TRACES OF A VOICE IN FISHES.

BY CHARLES C. ABBOTT, M. D.

IF speech be but the means of communicating emotions or intentions to other beings, even invertebrate animals possess faculties of the same nature. We see insects, such as ants, which live in so-called communities, carrying out elaborately preconcerted warlike undertakings and attacks. A beetle which in rolling the ball of dung inclosing its egg has allowed it to slip into a hole from which it is unable to extricate it, flies away, to return in a short time with a number of assistants suffi-

cient to push the ball up the sides of the declivity by coöperation of labor. These creatures must, therefore, unquestionably possess some means of communicating with each other concerning this combination. It requires no long observation of our song birds to distinguish the different tones by which they warn their young of danger, or call them to feed, or by which they attract each other to pair. These animals, therefore, have at their control a certain number of signals which are quite adequate to procure for them some few of the wants of their life, and these signals, as far as we can at present guess, have been acquired and inherited in the same manner as were their instincts." (Peschel.)

Although we are all familiar with the lazy drum-fish of our sea-coast, — and some may have heard those grunting sounds that have given this species its common name, — the little fishes of our inland brooks and more pretentious denizens of our rivers are looked upon as voiceless creatures; that if indeed they have ideas, they must express them entirely by movements, not of one portion, but by their whole bodies. But, in fact, the conditions that obtain among insects and birds, as detailed in our quotation from Dr. Peschel,[1] are, in a measure, applicable to our fishes; at least, in the several years of my studies of the habits of our more common species, I have concluded that certain sounds made by these fishes are really vocal efforts, and that their utterance is for the purpose of expressing an idea to others of their kind; and furthermore, that these sounds are closely connected with their breeding habits, although I have heard these same sounds at other seasons.

Probably no one has failed to notice the brilliant colors of the restless red-fin, as it darts to and fro through the clear waters of a crystal brook, or the crimson fins of the silvery roach, that ere summer has passed, pale to dull yellow and lose all their glow; but while with all our fishes there is at one time of the year a deepening of every tint, this is in no wise comparable to the gorgeous hues nature has vouchsafed to a certain few. My studies of the habits of these common fishes have suggested that the bright colors of spring, which are analogous to the breeding plumage of male birds, might possibly bear the same relationship to vocal sounds that the songs and plumage of birds bear to each other. With some exceptions, our finest songsters are dull-colored birds. Have our plainer-tinted fishes a compensation for this attraction of color in the ability to utter sounds?

[1] The Races of Man, page 101. By Oscar Peschel. D. Appleton & Co. 1876.

After several summers spent in observing the breeding habits of these common fishes, I have been able to form two tables, referring to the breeding habits and the relationship of color and supposed voice thereto, of sixteen species of fresh-water fishes. In the first of these, I have simply separated them into bright, and dull colored species; the bright coloration referring to the breeding dress or spring coloration. In the second list, I have separated them according to their supposed vocal powers, and absence of such powers; and it will be seen on comparison that a combination of voice and color does not occur.

TABLE I.[1]

Brilliant Colors.	*Dull or Silvery.*
Yellow perch.	Spineless perch.
Common sunfish.	Mud sunfish.
Banded sunfish.	Gizzard shad.
Red-fin.	Mullet.
	Eel.
	Cat-fish.
	Lamprey.

TABLE II.

Supposed Vocal Power.	*Voiceless.*
Spineless perch.	Yellow perch.
Mud sunfish.	Common sunfish.
Gizzard shad.	Red-tailed sunfish.
Mullet.	Banded sunfish.
Lamprey.	Chub.
Cat-fish.	Roach.
Eel.	Red-fin.
	Pike.
	Bill-fish.

We have here four species enumerated that are brilliantly colored, and seven that are dull or silvery; and of the former, none are believed to have any voice proper, while of the seven of the right-hand column, all are believed to be so endowed. In the right-hand column of Table II., it will be noticed that the "voiceless" species include the four highly colored fishes and five others, all of silvery tints, which I have carefully studied, that have no habit, so far as traceable, which would separate them from the list of species without voice. We can scarcely then avoid the conclusion, that with fishes as with birds the brilliantly colored males, as a rule, are mostly, if not wholly, dependent on their hues to attract the females in the amatory season.

Those who may be familiar with the common chub (*Semotilus*

[1] I have purposely omitted the sturgeon from the list of plainly colored fishes, as I desire to make a separate study of the habits of this fish.

corporalis) will doubtless urge as an exception, that the peculiar grunting sounds made by this fish when taken from the water entitle it to a place among the list of species supposed to have a voice; but I have not been able to detect this sound except at such a time, and as the fish is then out of water and struggling, it may be involuntary. On the other hand the deep bronze and golden-green tints of the fresh-water bass, or "mud sunfish" (*Acantharcus pomotis*), may be maintained to be a case of high coloration, and a sexual attraction; and the same might be said of the land-locked gizzard shad (*Dorosoma cepedianum*), but the former of these has been most frequently of all fishes observed by me to voluntarily utter sounds when confined in an aquarium; still I doubt not there are many exceptions, and one great objection, and at first it seems a fatal one, to the suggestions I have made is that there probably are so very many exceptions to the supposed rule. But to refer again to the case of birds. Assuming the correctness of evolution, as I do, then we need go back but a very short period in geological time to see the numerous species of our birds reduced to single representatives of each genus, and even far fewer of so-called genera. With the avifauna thus simplified, the differences that now exist between our sombre-hued songsters and gayly colored songless birds, were doubtless more marked; and might not this be held true of our fishes also? The vast influence brought to bear upon all animals by their surroundings and the increasing struggle for existence has evolved in later times and is evolving innumerable variations in the forms of life of the present time; and these changes have in so great a measure obscured the conditions that once characterized both our birds and fishes, in the matter of the relationship of voice and color, that what I believe to have been once a well-marked feature of animal life is now traced with difficulty. Nevertheless, the many instances of apparent voice that I have noticed, and their relationship as to color, induce me to believe that what is now scarcely a rule, perhaps, as obtaining among fishes, was once a law that governed them.

In studying these same fishes in another phase of their habits, we see that while all of the species enumerated are active throughout the day, it cannot be questioned that some of them are far more active at night, and shun, if undisturbed, the glare of midday sunshine. These partially, if not strictly nocturnal species are those that I have considered as having the power to give out or utter a truly vocal sound, and they are the more plainly

colored species. The brilliant tints being of little or no use by night necessitates the diurnal habits of those fishes possessing them, while the nocturnal species, with a voice as a compensation for color, are enabled to carry on a courtship in part by its aid which would be of little or no use during the day.

Having given an outline of the conclusions reached, as to the supposed relationship of voice and color among certain fishes, let us consider in detail the characteristic habits of two of the best-known and most widely differing species of the list given. As representing the voiceless but highly tinted fishes, let us take the common sunfish (*Pomotis vulgaris*), and on the other hand the equally familiar cat-fish (*Amiurus lynx*) as an instance of a fish that has the power of uttering a sound, — that has the rudiments of a voice.

With the bursting of the leaf-buds and disappearance of the ice from the shady nooks of our quiet inland ponds, the gayly tinted sunfish that all winter long has been lazily loafing in the deeper waters of his old-time haunts dons not another scaly coat, indeed, but so renews and polishes the old that he might well pass for another of his kind; and, coming boldly to the sunny shallows, darts restlessly about, admiring himself, I doubt not, but to his greater satisfaction being admired by others, and before the flowers of May have faded has gotten himself a mate. But the courtship of this gaudy fish has been no easy matter. Hundreds of his kind, as bright as he, have, like him, striven by the hour to clear the field of every rival; and the clear waters are often turbid with sand and grass torn from the bed of the stream, as the older males chase each other from point to point, endeavoring by a successful snap to rob each other of a fin. No courtship battles among birds are more earnestly fought; and as the bird with bedraggled feathers is wise enough to withdraw from the contest and quietly seek a mate when his soiled plumage is in part restored, so the sunfish with mangled fins retires from the nesting grounds. But not a sound has been made by these excited fishes, except that of the rippling water when cut by their spiny fins as they chanced to reach above the surface. Never, when for a moment quiet, have we chanced to see the delicate chain of silvery bubbles that escape from the mouth of the bass (mud sunfish) when, shall we say, calling to its mate? At night, I believe, the sunfish rests from his labors. I have not been able to detect any continuance of his spring-time vivacity after sunset, and am led to

conclude that his sole dependence in securing a mate is in his brilliant coloring.

What a contrast is presented in the lazy, dull-colored cat-fish that slowly wanders over the muddy bed of the stream, if perchance he is moving about at all, during the day! Not a motion can be detected that is not referable, without doubt, to so prosaic a matter as the search for food. If a dozen or more come together, it is but to hunt in concert, and nothing of the nature of a contest is to be seen. But after sunset, every one of their kind becomes suddenly more animated; there is a marked restlessness in their every movement, as they congregate in large numbers in some limited area. At such a time, their presence is to be detected not only by the aid of "submarine lanterns" and all the troublesome helps that one must employ to study fishes at night; there is an opportunity given to use one's ears as well as eyes, and by careful, patient waiting we may hear, even from the deeper waters, a gentle humming sound that, if noticed at all, by most people would be referred to the insect life teeming about them. If, knowing or suspecting the true origin of this gentle murmur, we can, without alarming the fish, float our boat carefully to a point directly above them, we will find that scores of chains of little air bubbles are rising to the surface; and as the sound increases or dies away, in proportion to the abundance or absence of the bubbles, it is safe to refer the sound to the fishes that by voluntarily expelling the air from their bodies produce the murmurs we have mentioned. But, thanks to the aquarium, by its aid we have confirmed it.

I have not the space, here, to enumerate all the circumstances connected with these voluntary emissions of sounds by certain of our fishes, seven species of which I have particularly mentioned. Brief references to the others must here suffice. Concerning the first mentioned of our little list, the spineless perch, or "pirate" (*Aphrodederus sayanus*): my knowledge of its habits have been mostly derived from aquarial studies, but although the diminutive size of the very largest specimens obtained — a little over four inches in length — rendered it very difficult to be certain that sound accompanied the expulsion of air from their bodies, I am almost sure I detected it, and the actions generally of the fish were such as to render it in a high degree probable that there was a sound heard by the female fishes of their kind.

Of the percoid, that I have here called the "mud sunfish"

(*Acantharcus pomotis*), there is no doubt. Not only in the muddy brooks where it is mostly found, but also when confined in an aquarium, this fish will utter at times a deep grunting sound that cannot be mistaken. That it is voluntary, too, is evident from the quick, nervous movement of the whole body, and wide distention of the gill-covers that accompanies the sound. These sounds and those of the cat-fish first called my attention to the subject of voluntary production of sound or "voice" in fishes. Like the spineless perch, this sunfish is, I think, strictly nocturnal in its habits, and, from aquarial observations I am led to believe, chooses a mate, and accompanies her to the nest for ovipositing only at night.

Of that interesting fish, the land-locked "gizzard shad" (*Dorosoma cepedianum*), my observations have led to the detection of a very audible, whirring sound, not unlike the deeper notes of a coarse string of an æolian harp. Those who may have noticed, at times, the vibrating thrill that arises from the wind passing over a number of telegraph wires, will have heard a sound nearly identical. I judge that both sexes utter this sound in concert; but it may be that during the early spring the sexes separate, to come together again some few weeks later, when spawning commences, and, in such a case, that only the males were "singing." We find, especially in the herring tribe, that the sexes migrate separately; but in the case of the gizzard shad, when land-locked, as there could be no migration, this separation probably does not occur.

The chub-sucker or mullet (*Moxostoma oblongum*) is another example of those dull-colored, nocturnal fishes that frequent streams with muddy beds thickly overgrown with water plants, and which have the power of audibly forcing air from their bodies. In April, with a noticeable deepening of their coloration, there is increased activity in every movement, and, wholly unlike their actions by day, at night they swim quite near the surface, and utter a single prolonged note accompanied by a discharge of air-bubbles. They appear to project their jaws just above the water, and force the air from beneath their gill-covers immediately below the surface, as there are two parallel streams of bubbles. When seen in the moonlight, these bubbles appear like minute silver beads. Swimming in this way, the mullet will often proceed a hundred yards, uttering their peculiar "call" four or five times while passing over that distance.

In the lamprey (*Petromyzon nigricans*) we have a semi-noc-

turnal species that I have had but few opportunities of observing closely, as it frequents rapidly running water and spends much the greater portion of its time under flat stones. On two occasions I have had opportunities of watching them, when paired, and thought that they uttered a peculiar sound, quite dissimilar to that of any other fish note I had heard, but it was unaccompanied so far as I could determine by a chain of air bubbles rising to the surface, such as always are seen to accompany the notes uttered by the chub-sucker or cat-fish. This same noise, or one very similar, was made by them when captured and taken from the water, and, in both instances, may have been involuntary. From their peculiar anatomy, they are an exceedingly interesting species with reference to the subject of voice so-called; and I regret that my experience when keeping them in an aquarium did not confirm my suspicions when studying them in their proper habitat. When in an aquarium, I occasionally heard a prolonged buzzing sound that had many of the characteristics of what I have considered voice in other species, but it was too monotonous and protracted to be considered a voluntarily produced sound or vocal effort. If the more voice-like sounds heard, as mentioned, are characteristic of their breeding season, then it probably is strictly a "love call," and certainly, when paired, these fishes are exceedingly amorous.

In all the instances so far mentioned of voluntarily expressed sounds or utterances of fishes, they have been referred to in connection with their ordinary breeding habits; not that they are never heard at other times, but because these "calls" or "songs," or whatever they should be considered, are a marked feature of that season. In our common eel (*Anguilla acutirostris*) we have an instance of a fish possessing unmistakable evidences of voice, yet which may be said to have no breeding season, at least when found far inland. Without inquiring into the still doubtfully determined breeding habits of the eel, it is sufficient here to say, that in countless thousands they pass from the sea up our rivers, and so, far inland through the most insignificant brooks, and certainly often reach isolated ponds. From these ponds they seldom escape. Here they grow to a large size, and live to a great age; yet summer after summer passes without any indication of their breeding. No species of fresh-water fish is more strictly nocturnal in its habits, and none are so easily studied, inasmuch as at night they are not only very active but keep continually near the surface. In the matter of voice, eels

utter a more distinctly musical sound than any other of those I have mentioned. It is a single note, frequently repeated, and has a slightly metallic resonance. I have heard this sound only at night, and never when the animal is taken from the water by day, as when captured by a hook, so that I presume it is not involuntary. When a large number of eels are congregated in a small space, as when feeding on some decayed animal, I have heard this note very frequently repeated, and from the volume of sound I judge that large eels utter only a note that is distinctly audible. It is well known that this fish occasionally leaves the water voluntarily and wanders a considerable distance to other streams or ponds; and when through protracted droughts a pond becomes quite dry, while other fishes perish, the eels suffer little inconvenience, as, snake-like, they crawl at night over a considerable stretch of land, guided by some undetermined instinct to the nearest water. At such a time the eel will occasionally utter this same clear note, especially if surprised. From what I have been able to determine concerning these overland journeys of the eel, they are undertaken only when the grass is well moistened with dew, and a surface of any extent devoid of thick vegetation is an effectual barrier to their progress. I would add, that I have noticed when "bobbing" for eels, namely, catching them without injury to their mouths, that when squirming about the bottom of the boat they not unfrequently utter this same sound, not inaptly compared, perhaps, to the faint squeak of a mouse.

I have given one instance, that of the common Pomotis, of a fish that is strictly a diurnal species, of bright coloration, and that passes through the various phases of courtship and nidification without uttering a sound; and on the other hand, more or less in detail, referred to several other fishes that are all of dull coloration, are nocturnal in their habits, and, whether voluntarily or not, certainly at times do utter sounds. They cannot be considered as simply making a noise, this arising from the unavoidable result of certain muscular movements. The action that produces the sound, on the contrary, I have been led to believe is one intentionally performed that the sound may result, and the fish has a distinct purpose in view in the latter, it being a call to others of its kind, which is responded to by the approach of those hearing it and for whom it was intended.

When we carefully study the entire ichthyic fauna of a given locality, say of a single small stream, as I have done in this case,

we shall undoubtedly find some exceptions to this supposed rule of dissociation of coloration and voice; but these may be less in number than appear to us, when we consider how great a number of diminutive species are found in every stream, that cannot be determined in which class they should be placed; for while many are dull colored and doubtless possess voice (the well-known mud minnow, *Melanura limi*, is an excellent example), this is too faint a sound for us to detect; but from the fact that this peculiarity can be determined in some of the larger species, it is not improbable that in earlier geological eras fishes generally were of sombre tints, and possessed more decided vocal powers than at present; and that in the subsequent differentiation of genera and species, color was more and more evolved as a generic character, and voice became proportionately less a feature of our fishes, but was retained in some and reäppears in still stronger development in those connecting links between fishes and the higher vertebrates, culminating in the batrachians, where it is perfected by the presence of a larynx.

In conclusion, it is well to quote briefly from an author who has most scientifically discussed this same subject.[1]

He writes: "Not only is there every reason to believe that the majority of sounds produced by fishes are not casual utterances, but are truly voluntary, but there is among such as give vent to them a most remarkable development of the organs of hearing in all essential particulars, for example, in the semi-circular canals, otoliths, and nerves, correlative with the degree of perfection of the instrument. Further than this, as the sounds generally excel in frequency and intensity at the breeding season, it will not be unreasonable to regard them, — granting, as we do, that the chirp of the cricket and the croak of the frog is each in its way an alluring serenade, — as nuptial hymns, or, to use language ascribed to Plutarch, as 'deafening epithalamia.' More than this; seeing that the carp, and others of the same family, have given unmistakable proofs of their aptitude to receive some rudiments of education, and in particular to perceive certain sounds, it can yet be possible that the moral admonitions of a St. Anthony of Padua — by many still regarded as a work of supererogation — may, no less than the amorous twang of the vesical zither, after all not have fallen upon totally deaf ears."

[1] Songs of Fishes. By John C. Galton. Popular Science Review, October, 1874. (Consult also Recherches sur les Bruits et Sons expressifs que sont entendre les Poissons d'Europe, par M. Dufossé. (Annales des Sciences Naturelles. Tom. xix., xx., 1874.) With many illustrations. This article doubtless inspired the excellent one by Mr. Galton. — EDITOR AMERICAN NATURALIST.)

THE GEOGRAPHICAL DISTRIBUTION OF ANIMALS: GENERAL CONCLUSIONS.[1]

BY ALFRED R. WALLACE.

HAVING now closed our survey of the animal life of the whole earth, — a survey which has necessarily been encumbered with a multiplicity of detail, — we proceed to summarize the general conclusions at which we have arrived, with regard to the past history and mutual relations of the great regions into which we have divided the land surface of the globe.

All the palæontological no less than the geological and physical evidence, at present available, points to the great land masses of the northern hemisphere as being of immense antiquity and as the area in which the higher forms of life were developed. In going back through the long series of the Tertiary formations in Europe, Asia, and North America, we find a continuous succession of vertebrate forms, including all the highest types now existing or that have existed on the earth. These extinct animals comprise ancestors or forerunners of all the chief forms now living in the northern hemisphere; and as we go back farther and farther into the past, we meet with ancestral forms of those types also, which are now either confined to or specially characteristic of the land masses of the southern hemisphere. Not only do we find that elephants and rhinoceroses and hippopotami were once far more abundant in Europe than they are now in the tropics, but we also find that the apes of West Africa and Malaya, the lemurs of Madagascar, the Edentata of Africa and South America, and the marsupials of America and Australia were all represented in Europe (and probably also in North America) during the earlier part of the Tertiary epoch. These facts, taken in their entirety, lead us to conclude that during the whole of the Tertiary and perhaps during much of the Secondary periods, the great land masses of the earth were, as now, situated in the northern hemisphere; and that here alone were developed the successive types of vertebrata, from the lowest to the highest. In the southern hemisphere there appear to have been three considerable and very ancient land masses, varying in extent from time to time, but always keeping distinct from each other, and represented, more or less completely, by Australia, South Africa, and South America of our time. Into these

[1] Chapter xvi. of The Geographical Distribution of Animals. New York: Harper and Brothers.

flowed successive waves of life, as they each in turn became temporarily united with some part of the northern land. Australia appears to have had but one such union, perhaps during the middle or latter part of the Secondary epoch, when it received the ancestors of its Monotremata and marsupials, which it has since developed into a great variety of forms. The South African and South American lands, on the other hand, appear each to have had several successive unions and separations, allowing first of the influx of low forms only (Edentata, Insectivora, and lemurs), subsequently of rodents and small Carnivora, and latest of all of the higher types of Primates, Carnivora, and Ungulata.

During the whole of the Tertiary period, at least, the northern hemisphere appears to have been divided, as now, into an eastern and a western continent; always approximating and sometimes united towards the north, and then admitting of much interchange of their respective faunas, but on the whole keeping distinct, and each developing its own special family and generic types, of equally high grade, and generally belonging to the same orders. During the Eocene and Miocene periods, the distinction of the Palæarctic and Nearctic regions was better marked than it is now, as is shown by the floras no less than by the faunas of those epochs. Dr. Newberry, in his Report on the Cretaceous and Tertiary Floras of the Yellowstone and Missouri Rivers, states, that although the Miocene flora of Central North America corresponds generally with that of the European Miocene, yet many of the tropical, and especially the Australian types, such as *Nakea* and *Dryandra*, are absent. Owing to the recent discovery of a rich Cretaceous flora in North America, probably of the same age as that of Aix-la-Chapelle in Europe, we are able to continue the comparison, and it appears that at this early period the difference was still more marked. The predominant feature of the European Cretaceous flora seems to have been the abundance of Proteaceæ, of which seven genera now living in Australia or the Cape of Good Hope have been recognized, besides others which are extinct. There are also several species of *Pandanus*, or screw-pine, now confined to the tropics of the eastern hemisphere, and along with these oaks, pines, and other more temperate forms. The North American Cretaceous flora, although far richer than that of Europe, contains no Proteaceæ or *Pandani*, but immense numbers of forest trees of living and extinct genera. Among the former we have oaks, beeches,

willows, planes, alders, dogwood, and cypress, together with such American forms as magnolias, sassafras, and liriodendrons. There are also a few not now found in America, as *Araucaria* and *Cinnamomum*, the latter still living in Japan. This remarkable flora has been found over a wide extent of country, New Jersey, Alabama, Kansas, and near the sources of the Missouri in the latitude of Quebec, so that we can hardly impute its peculiarly temperate character to the great elevation of so large an area. The intervening Eocene flora approximates closely in North America to that of the Miocene period, while in Europe it seems to have been fully as tropical in character as that of the preceding Cretaceous period, fruits of *Nipa*, *Pandanus*, *Anona*, *Acacia*, and many Proteaceæ occurring in the London clay at the mouth of the Thames.

These facts appear, at first sight, to be inconsistent, unless we suppose the climates of Europe and North America to have been widely different in those early times; but they may perhaps be harmonized on the supposition of a more uniform and a somewhat milder climate then prevailing over the whole northern hemisphere, the contrast in the vegetation of these countries being due to a radical difference of type, and therefore not indicative of climate. The early European flora seems to have been a portion of that which now exists only in the tropical and subtropical lands of the eastern hemisphere, and as much of this flora still survives in Australia, Tasmania, Japan, and the Cape of Good Hope, it does not necessarily imply more than a warm and equable temperate climate. The early North American flora, on the other hand, seems to have been essentially the same in type as that which now exists there, and which in the Miocene period was well represented in Europe; and it is such as now flourishes best in the warmer parts of the United States. But whatever conclusion we may arrive at on the question of climate, there can be no doubt as to the distinctness of the floras of the ancient Nearctic and Palæarctic regions; and the view derived from the study of their existing and extinct faunas — that these two regions have, in past times, been more clearly separated than they are now — receives strong support from the unexpected evidence now obtained as to the character and mutations of their vegetable forms, during so vast an epoch as is comprised in the whole duration of the Tertiary period.

The general phenomena of the distribution of living animals, combined with the evidence of extinct forms, lead us to conclude

that the Palæarctic region of early Tertiary times was, for the most part, situated beyond the tropics, although it probably had a greater southward extension than at the present time. It cer tainly included much of North Africa, and perhaps reached far into what is now the Sahara, while a southward extension of its central mass may have included the Abyssinian highlands, where some truly Palæarctic forms are still found. This is rendered probable by the fossils of Perim Island a little farther east, which show that the characteristic Miocene fauna of South Europe and North India prevailed so far within the tropics. There existed, however, at the extreme eastern and western limits of the region, two extensive equatorial land areas, our Indo-Malayan and West African sub-regions, both of which must have been united for more or less considerable periods with the northern continent. They would then have received from it such of the higher vertebrates as were best adapted for the peculiar climatal and organic conditions which everywhere prevail near the equator; and these would be preserved, under variously modified forms, when they had ceased to exist in the less favorable and constantly deteriorating climate of the north. At later epochs, both these equatorial lands became united to some part of the great South African continent (then including Madagascar), and we thus have explained many of the similarities presented by the faunas of these distant and generally very different countries.

During the Miocene period, when a subtropical climate prevailed over much of Europe and Central Asia, there would be no such marked contrast as now prevails between temperate and tropical zones; and at this time much of our Oriental region, perhaps, formed a hardly separable portion of the great Palæarctic land. But when, from unknown causes, the climate of Europe became less genial, and when the elevation of the Himalayan chain and the Mongolian plateau caused an abrupt difference of climate on the northern and southern sides of that great mountain barrier, a tropical and a temperate region were necessarily formed; and many of the animals which once roamed over the greater part of the older and more extensive region now became restricted to its southern or northern divisions, respectively. Then came the great change we have already described (vol. i. p. 288), opening the newly formed plains of Central Africa to the incursions of the higher forms of Europe, and following on this, a still further deterioration of climate, resulting in that marked contrast between temperate and tropical faunas, which is

now one of the most prominent features in the distribution of animal as well as of vegetable forms.

It is not necessary to go into any further details here, as we have already, in our discussion of the origin of the fauna of the several regions, pointed out what changes most probably occurred in each case. These details are, however, to a great extent speculative, and they must remain so till we obtain as much knowledge of the extinct faunas and past geological history of the southern lands as we have those of Europe and North America. But the broad conclusions at which we have now arrived seem to rest on a sufficiently extensive basis of facts, and they lead us to a clearer conception of the mutual relations and comparative importance of the several regions than could be obtained at an earlier stage of our inquiries.

If our views of the origin of the several regions are correct, it is clear that no mere binary division into north and south, or into east and west can be altogether satisfactory, since at the dawn of the Tertiary period we still find our six regions, or what may be termed the rudiments of them, already established. The north and south division truly represents the fact that the great northern continents are the seat and birthplace of all the higher forms of life, while the southern continents have derived the greater part, if not the whole of their vertebrate fauna from the north; but it implies the erroneous conclusion that the chief southern lands, Australia and South America, are more closely related to each other than to the northern continent. The fact, however, is that the fauna of each has been derived, independently, and perhaps at very different times, from the north, with which they therefore have a true genetic relation, while any intercommunion between themselves has been comparatively recent and superficial, and has in no way modified the great features of animal life in each. The east and west division represents — according to our views — a more fundamental diversity, since we find the northern continent itself so divided in the earliest Eocene and even in Cretaceous times, while we have the strongest proof that South America was peopled from the Nearctic, and Australia and Africa from the Palæarctic region; hence, the eastern and western hemispheres are the two great branches of the tree of life of our globe. But this division, taken by itself, would obscure the facts, firstly, of the close relation and parallelism of the Nearctic and Palæarctic regions, not only now, but as far back as we can clearly trace them in the past; and

secondly, of the existing radical diversity of the Australian region from the rest of the eastern hemisphere.

Owing to the much greater extent of the old Palæarctic region (including our Oriental) and the greater diversity of Mammalia it appears to have produced, we can have little doubt that here was the earliest seat of the development of the vertebrate type, and probably of the higher forms of insects and land-mollusks. Whether the Nearctic region ever formed one mass with it, or only received successive immigrations from it by northern land connections both in an easterly and westerly direction, we cannot decide; but the latter seems the most probable supposition. In any case, we must concede the first rank to the Palæarctic and Oriental regions, as representing the most important part of what seems always to have been the great continent of the earth, and the source from which all the other regions were supplied with the higher forms of life. These once formed a single great region which has been since divided into a temperate and a tropical portion, now sufficiently distinct, while the Nearctic region has, by deterioration of climate, suffered a considerable diminution of productive area, and has in consequence lost a number of its more remarkable forms. The two temperate regions have thus come to resemble each other, more than they once did, while the Oriental retains more of the zoölogical aspect of the great northern regions of Miocene times. The Ethiopian form having been once an insular region, where lower types of vertebrates alone prevailed, has been so overrun with higher types from the old Palæarctic and Oriental lands that it now rivals, or even surpasses, the Oriental region in its representation of the ancient fauna of the great northern continent. Both of our tropical regions of the eastern hemisphere possess faunas which are to some extent composite, being made up in different proportions of the productions of the northern and southern continents, — the former prevailing largely in the Oriental, while the latter constitutes an important feature in the Ethiopian fauna. The Neotropical region has probably undergone great fluctuations in early times; but it was, undoubtedly, for long periods completely isolated, and there developed the Edentate type of mammals and the Formicaroid type of passerine birds into a variety of forms, comparable with the diversified marsupials of Australia, and typical Passeres of the eastern hemisphere. It has, however, received successive infusions of higher types from the north, which now mingle in various degrees with

its lower forms. At an early period it must have received a low form of Primates, which has been developed into the two peculiar families of American monkeys; while its llamas, tapirs, deer, and peccaries came in at a later date, and its opossums and extinct horses probably among the latest. The Australian region alone, after having been united with the great northern continent at a very early date (probably during the Secondary period), has ever since remained more or less completely isolated, and thus exhibits the development of a primeval type of mammal, almost wholly uninfluenced by any incursions of a later and higher type. In this respect it is unique among all the great regions of the earth.

We see, then, that each of our six regions has had a history of its own, the main outlines of which we have been able to trace with tolerable certainty. Each of them is now characterized — as it seems to have been in all past time of which we have any tolerably full record — by well-marked zoölogical features, while all are connected and related in the complex modes we have endeavored to unravel. To combine any two or more of these regions, on account of existing similarities which are for the most part of recent origin, would obscure some of the most important and interesting features of their past history and present condition. And it seems no less impracticable to combine the whole into groups of higher rank, since it has been shown that there are two opposing modes of doing this, and that each of them represents but one aspect of a problem which can only be solved by giving equal attention to all its aspects.

For reasons which have been already stated and which are sufficiently obvious, we have relied almost exclusively on the distribution of living and extinct Mammalia in arriving at these conclusions. But we believe they will apply equally to elucidate the phenomena presented by the distribution of all terrestrial organisms, when combined with a careful consideration of the various means of dispersal of the different groups and the comparative longevity of their species and genera. Even insects, which are perhaps of all animals the farthest removed from Mammalia in this respect, agree in the great outlines of their distribution, with the vertebrate orders. The regions are admittedly the same, or nearly the same for both, and the discrepancies that occur are of a nature which can be explained by two undoubted facts, the greater antiquity, and the greater facilities for dispersal of insects.

But this principle, if sound, must be carried farther and be applied to plants also. There are not wanting indications that this may be successfully done; and it seems not improbable that the reason why botanists have hitherto failed to determine, with any unanimity, which are the most natural phytological regions, and to work out any connected theory of the migrations of plants is, because they have not been furnished with the clue to the past changes of the great land masses, which could only be arrived at by such an examination of the past and present distribution of the higher animals as has been here attempted. The difficulties in the way of the study of the distribution of plants, from this point of view, will be undoubtedly very great, owing to the unusual facilities for distribution many of them possess and the absence of any group which might take the place of the Mammalia among animals and serve as a guide and standard for the rest. We cannot expect the regions to be so well defined in the case of plants as in that of animals, and there are sure to be many anomalies and discrepancies, which will require long study to unravel. The six great regions here adopted are, however, as a whole, very well characterized by their vegetable forms. The floras of tropical America, of Australia, of South Africa, and of Indo-Malaya stand out with as much individuality as do the faunas, while the plants of the Palæarctic and Nearctic regions exhibit resemblances and diversities of a character not unlike those found among the animals.

This is not a mere question of applying to the vegetable kingdom a series of arbitrary divisions of the earth, which have been found useful to zoölogists, for it really involves a fundamental problem in the theory of evolution. The question we have to answer is, firstly, whether the distribution of plants is like that of animals, mainly and primarily dependent on the past revolutions of the earth's surface, or whether other and altogether distinct causes have had a preponderating influence in determining the range and limits of vegetable forms; and secondly, whether those revolutions have been in their general outlines correctly interpreted by means of a study of the distribution and affinities of the higher animals. The first question is one for botanists alone to answer, but on the second point, the author ventures to hope for an affirmative reply, from such of his readers as will weigh carefully the facts and arguments he has adduced.

The hypothetical view as to the more recent of the great

geographical changes of the earth's surface here set forth, is not the result of any preconceived theory, but has grown out of a careful study of the facts accumulated, and has led to a considerable modification of the author's previous views. It may be described as an application of the general theory of evolution, to solve the problem of the distribution of animals; but it also furnishes some independent support to that theory, both by showing what a great variety of curious facts are explained by its means, and by answering some of the objections which have been founded on supposed difficulties in the distribution of animals in space and time.

It also illustrates and supports the geological doctrine of the general permanence of our great continents and oceans, by showing how many facts in the distribution of animals can only be explained and understood on such a supposition, and it exhibits in a striking manner the enormous influence of the Glacial epoch, in determining the existing zoölogical features of the various continents. And lastly, it furnishes a more consistent and intelligible idea than has yet been reached by any other mode of investigation of all the more important changes of the earth's surface that have probably occurred during the entire Tertiary period, and of the influence of these changes in bringing about the general features, as well as many of the more interesting details and puzzling anomalies of the geographical distribution of animals.

RECENT LITERATURE.

MEMOIRS OF THE GEOLOGICAL SURVEY OF KENTUCKY.[1] — The first fruits of the reëstablished Geological Survey of Kentucky appear in a large and admirably illustrated volume of memoirs. Professor Shaler publishes papers on the antiquity of the caverns and on the fossil brachiopods of the Ohio Valley, and, in conjunction with Mr. Carr contributes the first of a series of papers on the prehistoric remains of Kentucky; while Mr. Allen furnishes an elaborate memoir on the American bisons, living and extinct. The first of Professor Shaler's papers has already appeared in the memoirs of the Boston Natural History Society, and Mr. Allen's monograph is published simultaneously by the Museum of Comparative Zoölogy. The latter paper forms the bulk of the volume (246 pp.) and is illustrated by twelve plates, half of them double, and by a map of North America. It is one of the most com-

[1] *Memoirs of the Geological Survey of Kentucky.* N. S. SHALER, Director. Vol. I. Cambridge, 1876. 4to, pp. 360, 27 plates, 1 map.

plete monographs ever published in this country, and a notable contribution to American science. The author recognizes two species of fossil bisons in America, *B. latifrons* and *B. antiquus* and a single living species, *B. Americanus*, of which he considers *B. antiquus* the immediate progenitor. The systematic part of the work, including a full account of the variation and habits of the recent species, extends over seventy pages, and the plates are illustrative of this portion. The map accompanies the larger part of the work, which relates to the past and present geographical distribution of the American bison and presents an appalling picture of the reckless waste and rapidly diminishing numbers of this noble animal. By most painstaking research among historical works and systematic inquiry among living witnesses, he has established the boundaries of the range of the "buffalo" as it existed when the white man first landed in America and at successive epochs to the present time, when it has become separated into a northern and a southern herd occupying comparatively restricted areas. The details extend over one hundred pages, but in the first part of his work Mr. Allen gives a general summary, as follows: —

"The habitat of the bison formerly extended from Great Slave Lake on the north, in latitude about 62°, to the northwestern provinces of Mexico, as far south as latitude 25°. Its range in British North America extended from the Rocky Mountains on the west to the wooded highlands about six hundred miles west of Hudson's Bay, or about to a line running southeastward from the Great Slave Lake to the Lake of the Woods. Its range in the United States formerly embraced a considerable area west of the Rocky Mountains, its recent remains having been found in Oregon as far west as the Blue Mountains, and further south it occupied the Great Salt Lake Basin, extending westward even to the Sierra Nevada Mountains, while less than fifty years since it existed over the head waters of the Green and Grand rivers, and other sources of the Colorado. East of the Rocky Mountains its range extended southward far beyond the Rio Grande, and eastward throughout the region drained by the Ohio River and its tributaries. Its northern limit east of the Mississippi was the Great Lakes, along which it extended eastward to near the eastern end of Lake Erie. It appears not to have occurred south of the Tennessee River, and only to a limited extent east of the Alleghanies, chiefly in the upper districts of North and South Carolina."

"Its present range embraces two distinct and comparatively small areas. The southern is chiefly limited to Western Kansas, a part of the Indian Territory, and Northwestern Texas, — in all together embracing a region about equal in size to the present State of Kansas. The northern district extends from the sources of the principal southern tributaries of the Yellowstone northward into the British Possessions, embracing an area not much greater than the present Territory of Montana.

Over these regions, however, it is rapidly disappearing,[1] and at its present rate of decrease will certainly become wholly extinct during the next quarter of a century." (Pages 54–55.)

There can be no question that the present generation will see the utter extinction of the bison unless some means are speedily taken by the general government, or by the territories to which its range is now restricted, to protect it by the establishment and stringent enforcement of laws providing for close time and limited slaughter. One hundred thousand killed in four months around Fort Dodge; two hundred thousand in a single season in Kansas, merely for the hides; three thousand by one man in one winter, — such are the statistics to which our attention is called.

Mr. Allen also gives a chapter on the products of the bison, the chase, and the possibilities of domestication; and Professor Shaler adds an interesting note on its age in the Ohio Valley, where he judges that the animal made its advent very recently, principally because its bones occur at Big Bone Lick only in the more superficial strata, where they are exceedingly abundant.

Professor Shaler's paper on the brachiopods is the first of a series, and treats of but a few species; these, however, are described with the greatest minuteness and care and very richly illustrated by heliotypes. In their joint essay on prehistoric remains, Messrs. Shaler and Carr discuss implements only, leaving other subjects for future treatment. All of the objects they describe and figure are "surface finds," and they profess to make no attempt to assign any of the specimens that have come within their observation to any particular period of time or phase of civilization. The introductory remarks on the mode of manufacturing stone implements by savage races and the chapters on the source of distribution of the stone implements of Kentucky, and on their antiquity, will be found very interesting.

HAECKEL'S HISTORY OF CREATION.[2] — Had Mr. Darwin when he first conceived the idea of natural selection, on his return from the voyage of the Beagle, had this book of Haeckel's thrust into his hands, he might then have stood aghast at the lengths to which the audacious German author goes. Here is a genealogical table of the entire organic world — the work of how many coming centuries we dare not predict — anticipated and set down in actual tables with all the assurance and confidence of an old-time prophet. The missing links even are all christened and diagnosed, from those which he thinks connected man with the

[1] If Colonel Dodge's statements in his recently published work, The Hunting-Grounds of the Great West, may be trusted, the range of the bison was already much restricted in 1876.

[2] *The History of Creation: or, the Development of the Earth and its Inhabitants by the Action of Natural Causes.* From the German of ERNST HAECKEL. The Translation revised by Prof. E. RAY LANKESTER. In 2 vols. New York: D. Appleton & Co. 1876. 12mo. $5.00.

monkeys to those which bound him to the Ascidians, and so on to the "primordial slime." As to reducing man's free will to that of a monad, his soul to the functional activity of the brain, his creator to the energy pervading matter, — in this Haeckel was caught napping; it is an old story. We are from first to last struck by the guileless faith of the man, a quality sometimes combined with an intensity of purpose and, we may add, an intolerance of opposing views which characterize the seer. We have here none of the halting in judgment and caution of Darwin, but rather the special pleading of the advocate of a unique theory which gives no quarter to any other.

The merit of the History of Creation is that it gives a rapid, clear-cut, dogmatic sketch of the subject. And though Haeckel's mode of settling the universe may be quite different from ours, his sketch of the origin of the animal world may be a rough approximation to what will probably be found on future research a reasonably truthful history. As an exposition of Darwinism as such, with its possible, not probable, consequences, it is the best in the language, now that we have such an excellent translation of the Geschöpfungsgeschichte which was published in 1868. The work is certainly original and striking in its many suggestions, and it has this unusual merit, that as an exposition of Darwinism by an ultra Darwinian it gives Lamarck full credit as the founder of the modern doctrine of transmutation or evolution. The work has so long been in the hands of the public that it would be superfluous for us to enter into a more detailed criticism or examination of its contents, but in closing we would say that any naturalist who has not read it has a treat before him, whether he accepts all the author's conclusions or not.

THE WARFARE OF SCIENCE.[1] — Though the battle of evolution has been fought, and the victory of the evolutionists complete, divines and metaphysicians falling into the lines of the victors, there are some who do not seem to be aware that they have been vanquished. Their eyes may be opened by President White's candid and impartial review of the struggles of scientific men with the bigoted of past ages as well as of the present period. He concludes: "First. In every case, whether the war has been long or short, forcible or feeble, science has at last gained the victory. Secondly. In every case interference with science, in the supposed interest of religion, has brought dire evils on both. Thirdly. In every case while this interference, during its continuance, has tended to divorce religion from the most vigorous thinking in the world and to make it odious to multitudes of the most earnest thinkers, the triumph of science has led its former conscientious enemies to make new interpretations and lasting adjustments, which have proved a blessing to religion, ennobling its conceptions and bettering its methods."

JOHNSON'S CYCLOPÆDIA.[2] — We have already called attention to

[1] *The Warfare of Science.* By ANDREW D. WHITE, LL. D. New York: D. Appleton & Co. 12mo, pp. 151. $1.00.

[2] *Johnson's New Universal Cyclopædia: a Scientific and Popular Treasury of Useful*

this work and to the features that render it especially serviceable to naturalists. It is strong in the scientific articles. The present volume contains articles by Abbe, Barnard, T. M. Brewer, Cope, Farlow, Gray, Goodale, Gill, Guyot, Henry, Marsh, Mayer, Morgan, Newberry, Packard, Pumpelly, Riley, Shaler, Verrill, and Wurtz. We regret to see no biographical notice of the late Mr. F. B. Meek, so eminent as a palæontologist, nor of Haeckel or Gegenbaur. The fourth volume will appear early this year.

RECENT BOOKS AND PAMPHLETS. — The Geographical Distribution of Animals. With a Study of the Relations of Living and Extinct Faunas, as elucidating the Past Changes of the Earth's Surface. By Alfred Russel Wallace. In two volumes. With Maps and Illustrations. New York: Harper & Brothers. 1876. 8vo, pp. 503, 607. $10.00.

Climate and Time in their Geological Relations: a Theory of Secular Changes of the Earth's Climate. By James Croll. New York; D. Appleton & Co. 1875. 12mo, pp. 577.

The History of Creation: or the Development of the Earth and its Inhabitants by the Action of Natural Causes. A popular exposition of the Doctrine of Evolution in general, and of that of Darwin, Goethe, and Lamarck in particular. From the German of Ernst Haeckel. The Translation revised by Prof. E. Ray Lankester. In 2 vols. New York: D. Appleton & Co. 1876. 12mo, pp. 374, 408. With Illustrations. $5.00.

A Class-Book of Chemistry, on the Basis of the New System. By Edward L. Youmans, M. D. Rewritten and revised, with many new Illustrations. New York: D. Appleton & Co. 1876. 12mo, pp. 348. $1.75.

Elements of Physics or Natural Philosophy. By Neil Arnott. Seventh edition, edited by Alexander Bain and A. S. Taylor. New York: D. Appleton & Co. 1877. 12mo, pp. 873. $3.00.

Inventional Geometry: a Series of Problems, intended to familiarize the Pupil with Geometrical Conceptions, and to exercise his Inventive Faculty. By W. G. Spencer. With a Prefatory Note by Herbert Spencer. New York: D. Appleton & Co. 1877. Small 12mo, pp. 97.

Lessons from Nature, as manifested in Mind and Matter. By St. George Mivart. New York. 1876. 12mo, pp. 449. $2.00.

The Warfare of Science. By President A. D. White. New York: D. Appleton & Co. 1876. 12mo, pp. 151. $1.00.

Nature and Life. Facts and Doctrines relating to the Constitution of Matter, the New Dynamics, and the Philosophy of Nature. By Ferdinand Papillon. Translated from the second French edition. By A. R. Macdonough. New York: D. Appleton & Co. 1875. 12mo, pp. 363. $2.00.

The Chemistry of Light and Photography. By Dr. Hermann Vogel. With 100 Illustrations. (International Scientific Series.) New York: D. Appleton & Co. 1875. 12mo, pp. 286. $2.00.

The Five Senses of Man. By Julius Bernstein. (The International Scientific Series.) With 91 Wood-Cuts. New York: D. Appleton & Co. 1876. 12mo, pp. 304. $1.75.

The Nature of Light, with a General Account of Physical Optics. By Dr. Eugene Lommel. (The International Scientific Series.) With 188 Illustrations, and a Plate of Spectra in Chromo-lithography. New York: D. Appleton & Co. 1876. 12mo, pp. 356. $2.00.

Knowledge. Illustrated with Maps, Plans, and Engravings. Editors-in-chief, F. A. P. BARNARD and ARNOLD GUYOT. In 4 vols. Vol. iii. Lichfield—R. A. J. Johnson & Son. New York. 1877. 4to, pp. 1760. $10.00 for each volume.

Mines and Mineral Statistics of New South Wales, etc. Compiled by direction of the Hon. John Lucas, M. P., Minister for Mines. Also Remarks on the Sedimentary Formations of New South Wales. By the Rev. W. B. Clarke, etc. Sydney. 1875. 8vo, pp. 252.

The Art of Projecting. A Manual of Experimentation in Physics, Chemistry, and Natural History with the Porte-Lumière and Magic Lantern. By Prof. A. E. Dolbear. Illustrated. Boston: Lee & Shepard. 1877. 12mo, pp. 158. $1.50.

Thier Leben. Von A. E. Brehm. Erste Reihe. Die Handthiere. Heft i. Leipzig. 1877. 8vo. Profusely illustrated. For sale by B. Westermann & Co., New York.

Science Lectures at South Kensington. Photography. By Captain Abney. Sound and Music. By Dr. W. H. Stone. Kinematic Models. By Professor Kennedy. With Illustrations. London and New York: Macmillan & Co. 1876. 12mo. 20 cents each.

Manchester Science Lectures for the People. Eighth Series. 1876–77. What the Earth is Composed of. Three Lectures by Professor Roscoe. With Illustrations. London and New York: Macmillan & Co. 1876. 12mo, pp. 40. 20 cents.

Scientific Results of the Exploration of Alaska. By the parties under the charge of W. H. Dall, during the Years 1865–1874. Vol. i., No. 1. Introductory Note on the Marine Faunal Regions of the North Pacific, by W. H. Dall. Art I. Report on the Hydroids, by S. F. Clark, with Plates i–x. Art. II. On the Extension of the Seminal Products in Limpets, with Remarks on the Phylogeny of the Docoglossa, by W. H. Dall. December, 1876. W. H Dall, Smithsonian Institution. Washington, D. C. 8vo, pp. 34.

Bulletin of the Illinois Museum of Natural History. No. 1. Bloomington, Ill. December, 1876. 8vo, pp. 76.

Report upon New Species of Coleoptera collected by the Expeditions for Geographical Surveys west of the 100th Meridian. Lt. G. M. Wheeler in charge. By J. L. LeConte; being extract from Appendix JJ of the Annual Report of the Chief of Engineers for 1876. Washington, D. C. 8vo, pp. 5.

Biographical Notice of the late Archibald R. Marvine. By J. W. Powell. (From the Bulletin of the Philosophical Society of Washington, D. C.) 8vo, pp. 8.

Palæontological Bulletin, No. 23. On some Extinct Reptiles and Batrachia from the Judith River and Fox Hills Beds of Montana. By E. D. Cope. (Extracted from the Proceedings of the Academy of Natural Sciences of Philadelphia, December, 1876.) 8vo, pp. 20.

Half Hours with Insects. By A. S. Packard, Jr. Boston: Estes & Lauriat. 1877. 12mo, pp. 384. $2.50.

Forest Culture and Eucalyptus Trees. By Ellwood Cooper. San Francisco. 1876 12mo, pp. 204. $1.50.

GENERAL NOTES.

BOTANY.[1]

A List of the Lichenes found growing within Twenty Miles of Yale College.

1. Ramalina, *Ach.*, *De Not.*
   1. calicaris, *Fr.*, var. fraxinea, *Fr.*, on trees; and var. farinacea, *Fr.* on rocks; and var. canaliculata, *Fr.*
   2. rigida, *Ach.* On cedars (*J. Virginiana*), rare; Short Beach, Branford; *Alfred Barron.*

[1] Conducted by Prof. G. L. Goodale.

2. CETRARIA, *Ach.*, *Fr.*
    1. Islandica, *Ach.* On dry ground in open woods.
    2. ciliaris, *Ach.* On old fence rails and dead trees.
    3. lacunosa, *Ach.*, and var. Atlantica, *Tuckerm.* On trees, etc. Not very common.
    4. aleurites (*Ach.*), *Th.*, *Fr.* Only one specimen found, on an old fence rail; Killingworth; *F. W. H.*
3. EVERNIA, *Ach.*, *Mann.*
    prunastri (*L.*), *Ach.* Killingworth, *F. W. H.*; Orange, *Prof. D. C. Eaton.* On rocks; not common.
4. USNEA, *Ach.*
    1. barbata (*L.*), *Fr.*, var. florida, *Fr.*, and var. rubiginea, *Michx.*, and var. dasypoga, *Fr.* The last var. forming long pendent gray clusters from dead limbs of our forest trees.
    2. angulata, *Ach.* Near Lake Saltonstall; *Prof. Eaton.* Not very common.
5. ALECTORIA (*Ach.*), *Nyl.*
    jubata (*L.*) var. chalybeiformis, *Ach.* Mostly on old fence rails.
6. THELOSCHISTES, *Norm.*, *Tuckerm.*
    1. parietinus (*L.*), *Norm.*, and var. lychneus, *Schær.* On rocks and trunks of trees.
    2. chrysophthalmus (*L.*), *Norm.*, and var. flavicans, *Wallr.* On trunks and branches of trees: a pretty species with golden eyes.
    3. concolor (*Dicks.*), (*T. candelarius* (*Ach.*), *Nyl.*, var. *stellata*, *Nyl.*). On bark of trees.
7. PARMELIA (*Ach.*), *De Not.*
    1. perforata (*Jacq.*), *Ach.*, and var. crinita, *Tuckerm.* Especially abundant on old stone walls.
    2. tiliacea (*Hoffm.*), *Floerk.* On stones and bark of trees.
    3. Borreri, *Turn.*, and var. rudecta, *Tuckerm.* On old fence rails; Killingworth; *F. W. H.*
    4. saxatilis (*L.*), *Fr.* Wallingford, *Alfred Barron*; Killingworth, *F. W. H.* On rocks.
    5. physodes (*L.*), *Ach.* Old rails, etc.
    6. colpodes, *Ach.* Wallingford; *A. Barron.*
    7. caperata (*L.*), *Ach.* Old fence rails and trunks of trees.
    8. conspersa (*Ehrh.*), *Ach.* Particularly abundant on exposed rocks and on old stone walls. Our most common species.
    9. olivacea (*L.*), *Ach.* On living and dead bark of trees.
8. PHYSCIA (*Fr.*), *Th.*, *Fr.*
    1. aquila (*Ach.*), *Nyl.*, var. detonsa, *Tuckerm.* On rocks.
    2. pulverulenta (*Schreb.*), *Nyl.* Wallingford, *A. Barron*; Killingworth, *F. W. H.* On rocks and trunks.
    3. speciosa (*Wulf.*, *Fr.*), and var. hypolenca, *Ach.*, and var. lencomela (*Eschw.*). On rocks, etc.

4. stellaris (*L.*), *Nyl.*, and var. hispida, *Fr.* On rocks and bark of trees.
5. obscura (*Ehrh.*), *Nyl.*, and var. ciliata, *Tuckerm.*, and var. erythrocardia, *Tuckerm.*, and var. adglutinata, *Schær.* On rocks; the latter var. abundant on currant bushes (*Ribes rubrum*).

9. UMBILICARIA, *Hoffm.*
1. pustulata (*L.*), *Hoffm.* According to my observations, this species is most common on high rocks in river bottoms, where it is exposed to the water in times of freshets.
2. Dillenii, *Tuckerm.* Same habitat as above.
3. Muhlenbergii (*Ach.*), *Tuckerm.* On rocks.

10. STICTA (*Schreb.*), *Delis.*
1. crocata (*L.*), *Ach.* On trunks and rocks.
2. quercizans (*Michx.*), *Ach.* On rocks; not common. Killingworth, *F. W. H.*; Orange, *F. W. H.*
3. pulmonaria (*L.*), *Ach.* On trunks of trees.
4. glomerulifera (*Lightf.*), *Delis.* On rocks.

11. NEPHROMA, *Ach.*
1. lævigatum, *Ach.* Killingworth and Orange; *F. W. H.* Not very common.

12. PELTIGERA (*Hoffm.*), *Fée.*
1. aphthosa (*L.*), *Hoffm.* Moist, mossy banks, among woods.
2. canina (*L.*), *Hoffm.*, and var. spuria, *Ach.* On damp ground.
3. polydactyla (*Neck.*), *Hoffm.* Damp ground in woods, etc.
4. rufescens (*Neck.*), *Hoffm.* Damp ground in woods, etc.

13. PANNARIA, *Delis.*
1. lanuginosa (*Ach.*), *Koerb.* Killingworth; *F. W. H.* Trunks and earth.
2. lurida (*Mont.*), *Nyl.* On the ground and rocks.
3. tryptophylla, *Ach.*, *Mass.* On basalt; Hampden; *Prof. Eaton.*
4. microphylla (*Sw.*), *Del.* Trunks, etc.
5. leucosticta, *Tuckerm.* Trunks, banks, etc. Killingworth; *F. W. H.*
6. molybdæa (*Pers.*), *Tuckerm.*, var. cronia, *Nyl.* Trunks, rocks, etc. Killingworth; *F. W. H.*

14. EPHEBE, *Fr.*
pubescens (*Ach.*), *Fr.* West Rock; *Prof. Eaton.*

15. COLLEMA (*Hoffm.*), *Fr.*
1. flaccidum, *Ach.* Bark, especially of the cedar (*J. Virginiana*).
2. nigrescens (*Huds.*), *Ach.* Same habitat as above.

16. LEPTOGIUM, *Fr.*
1. lacerum (*Sw.*), *Fr.* Moist rocks, etc.
2. pulchellum (*Ach.*), *Nyl.* Moist rocks, earth, etc.
3. tremelloides (*L.*), *Fr.* Earth and rocks.
4. chloromelum (*Sw.*), *Nyl.* Moist rocks.

5. myochroum (*Ehrh.*), *Schær.*, var. saturninum (*Dicks.*), *Tuckerm.* Moist rocks, etc.

17. HYDROTHYRIA, *Russell.*

venosa, *Russell.* Rivulets; Mt. Carmel and West Rock; *Prof. Eaton.*

18. PLACODIUM (*D. C.*) *Naeg.*, and *Hepp.*

1. elegans, *D. C.*) Trunks of trees, etc.
2. vitellinum (*Ehrh.*), *Hepp.* Wallingford: *A. Barron.*
3. cerinum (*Hedw.*), *Naeg.*, and var. hæmatites, *Fr.*
4. aurantiacum (*Lightf.*), *Naeg.* Trunks.

19. LECANORA, *Ach.*, *Tuckerm.*

1. muralis (*Schreb.*), *Schær.* Wallingford; *A. Barron.*
2. pallescens (*L.*), *Fr.* Rocks; Killingworth; *F. W. H.*
3. tartarea (*L.*), *Ach.*, and var. frigida, *Ach.* Rocks.
4. subfusca (*L.*), *Ach.* On trees and rocks, mostly the latter.
5. albella, *Ach.* (*L. pallida* (*Schreb.*), *Schær.*), and var. cæsio-rubella (*Ach.*). On living bark.
6. varia (*Ehrh.*), *Fr.* On old board and rail fences.
7. cinerea (*L.*), *Fr.* Stones, etc.
8. cervina (*Pers.*), *Sommerf.*, var. discreta, *Fr.*, and var. privigna, *Ach.*, and var. clavus, *D. C.* Killingworth; *F. W. H.* Rocks and stones.

20. RINODINA, *Mass.*, *Stizenb.*

1. sophodes (*Ach.*), var. confragosa, *Nyl.* Rocks and stones. Killingworth, *F. W. H.*; Wallingford, *A. Barron.*
2. constans (*Nyl.*), *Tuckerm.* Wallingford; *A. Barron.*

21. PERTUSARIA, *D. C.*

1. pertusa (*L.*), *Ach. s. Por.* Trunks of trees and rocks.
2. leioplaca (*Ach.*), *Schær.* Trunks and rocks.
3. velata (*Turn.*), *Nyl.* Mostly on trunks.
4. multipuncta (*Sm.*), *Nyl.* Trunks and branches.
5. pustulata (*Ach.*), *Nyl.* Trunks and branches.
6. globularis, *Ach.* Rocks and trunks.

22. CONOTREMA, *Tuckerm.*

urceolatum (*Ach.*), *Tuckerm.* Wallingford, *A. Barron*; Killing worth, *F. W. H.* On bark of trees, especially on maples (*Acer rubrum* and *A. saccharinum*).

23. URCEOLARIA (*Ach.*), *Flot.*

1. scruposa (*L.*), *Ach.* Wallingford; *A. Barron.*
2. actinostoma, *Pers.* Sent from Wethersfield to *Mr. Willey.*

24. STEREOCAULON, *Schreb.*

paschale, *Laur.* On rocks at Mt. Carmel, etc.

25. CLADONIA, *Hoffm.*

1. papillaria (*Ehrh.*), *Hoffm.* On dry hills. Killingworth; *F. W. H.*
2. alcicornis, *Fr.* Rocks and earth.

3. pyxidata (*L.*), *Fr.* Earth.
4. cariosa (*Ach.*), *Spreng.* Earth.
5. fimbriata (*L.*), *Fr.*, and var. adspersa, *Tuckerm.* Earth, etc.
6. gracilis (*L.*), *Fr.*, and var. verticillata, *Fr.* Earth.
7. mitrula, *Tuckerm.* Wallingford; *A. Barron.* Earth.
8. furcata (*Huds.*), *Fr.*, and var. cristata, *Fr.*, and var. racemosa, *Flk.*, and var. lacunosa, *Flk.* Dry hills and open woods.
9. rangiferina (*L.*), *Hoffm.*, and var. sylvatica, *L.*, and var. alpestris, *L.* Dry hills and open woods.
10. uncialis (*L.*), *Fr.* Hilly ground among woods.
11. lacunosa, *Del.* Hilly ground among woods.
12. cornucopioides (*L.*), *Fr.* Rich ground and on rotten stumps.
13. cristatella, *Tuckerm.* Mostly on decayed stumps and fence rails.

26. Bæomyces, *Pers.*, *Nyl.*
 roseus, *Pers.* Sandy banks.

27. Biatora, *Fr.*
1. vernalis (*L.*), *Th.*, *Fr.* Earth and trees.
2. russula (*Ach.*), *Mont.* Killingworth; *F. W. H.* Trees; exceedingly rare.
3. sanguineo-atra (*Fr.*), *Tuckerm.* Moist banks and trunks.
4. exigua (*Chaub.*), *Fr.* Bark of trees.
5. rubella (*Ehrh.*), *Rabenh.*, and var. muscorum, *Nyl.* Moist banks.

28. Lecidea (*Ach.*), *Fr.*
1. albo-cœrulescens, *Fr.* On rocks and stones.
2. contigua, *Fr.*, *Nyl.* On rocks, etc.
3. spilota, *Fr.* Wallingford; *A. Barron.*

29. Buellia, *De Not.*, *Tuckerm.*
1. lactea, *Mass.* Wallingford; *A. Barron.*
2. lepidastra, *Tuckerm.* On rocks. Wallingford, *A. Barron;* Killingworth, *F. W. H.*
3. parasema (*Ach.*), *Koerb.* Trunks and branches.
4. myriocarpa (*D. C.*), *Mudd.* Rocks, trees (?), etc. Killingworth; *F. W. H.*
5. petræa (*Flot.*), *Tuckerm.* On rocks and stones. Killingworth; *F. W. H.*

30. Opegrapha (*Humb.*), *Ach.*, *Nyl.*
 varia (*Pers.*), *Fr.*

31. Graphis (*Ach.*), *Nyl.*
 scripta (*L.*), *Ach.*, and var. limitata, *Schær.* Bark of trees. Killingworth, *F. W. H.;* Wallingford, *A. Barron.*

32. Arthonia, *Ach.*, *Nyl.*
1. astroidea, *Ach.*, *Nyl.* Bark of trees. Killingworth; *F. W. H.*
2. punctiformis, *Ach.* Bark of trees. Killingworth; *F. W. H.*
3. tædiosa, *Nyl.* Bark of trees, and rocks (?). Killingworth; *F. W. H.*

33. MYCOPORUM (*Flot.*), *Nyl.*
   pycnocarpum, *Nyl.* Killingworth; *F. W. H.*
34. ACOLIUM (*Fée.*), *De Not.*
   tigillare (*Ach.*), *D. N.* Wallingford; *A. Barron.*
35. CALICIUM, *Pers.*, *Fr.*
   subtile, *Fr.* On old boards and fence rails. Killingworth; *F. W. H.*
36. ENDOCARPON, *Hedw.*, *Fr.*
   miniatum (*L.*) *Schær.*, and var. complicatum, *Schær.*, and var. aquaticum, *Schær.* On submerged stones in rivulets; also on damp exposed rocks.
37. TRYPETHELIUM, *Spreng.*, *Nyl.*
   virens, *Tuckerm.* Wallingford; *A. Barron.*
38. PYRENULA (*Ach.*), *Naeg.*, and *Hepp.*
   1. punctiformis (*Ach.*), *Naeg.* On trunks of trees. Killingworth; *F. W. H.*
   2. nitida, *Ach.* On trunks of trees. Wallingford, *A. Barron;* Killingworth, *F. W. H.* — F. W. HALL.

MINOT'S NEW ENGLAND BIRDS; ADDITIONS. — In my late work on New England Birds, by carelessly overlooking one of my own memoranda, I omitted mention of the Swallow-tailed Kite (*Nauclerus forficatus*), once *seen* near Whately, Mass., of the melanistic Swainson's Buzzard (*Buteo Swainsoni, insignatus*), *captured* in Massachusetts, and of the Arkansas Flycatcher (*Tyrannus verticalis*) recorded from Plympton Me. *Helminthophaga pinus* is a summer resident at Saybrook, Conn. (*Purdie.*) December 1876. — H. D. MINOT.

LARGE TRUNKS OF KALMIA LATIFOLIA. — It is well known that this *Kalmia* attains its maximum size in the southern Alleghanies. Probably nothing upon record exceeds or even equals the following measurements of the girth of two trees which grow, along with others not very much smaller, in the bottom of a dell back of Cæsar's Head, on the extreme western border of South Carolina. One trunk, at a foot or so from the ground,measured four feet one and a quarter inches in circumference, and, rising without division, maintains a size approaching this and gradually lessening, for six or seven feet.

Another trunk measured three feet four inches in girth above the first limb or fork; below it, at nearly one foot from the ground, it measured four feet and four inches. The measurements were taken September 2, 1876, by Dr. George Engelmann, William M. Canby, and ASA GRAY.

THE PRODUCTION OF STARCH IN CHLOROPHYLL-GRANULES. — Böhm asserts that if light is sufficiently intense to induce assimilation in green leaves, it has the power to cause an immediate transfer of starch *from* the stem, where elaborated matters may be stored, *to* the chlorophyll-granules. For this reason he believes that many observations hitherto made in regard to the immediate production of starch from carbonic

dioxide in chlorophyll are untrustworthy. Such experiments should be made upon plants which have no starch already stored up, or upon detached leaves which contain no starch.

THE EFFECT OF FROST ON CHLOROPHYLL-GRANULES. — Haberlandt states that the granules except in evergreens undergo changes at 4° to 6° C. The granules thus affected contain cavities (vacuoles), become rent on the outside, and aggregate into larger or smaller masses. The granules which contain starch are more easily destroyed by frost than those which contain none. The chlorophyll in the palisade tissue (the denser parenchyma) is more easily injured than that in the spongy tissue, and the latter than that in the guardian cells of the stomata.

DICHOGAMY OF AGAVE. — The flowering of a plant of *Agave yuccæfolia* Red. (Bot. Mag. t. 3213), in a private collection near Boston, has given abundant opportunity to watch the development of its flowers, and to confirm in regard to this species Engelmann's statement (Notes on Agave. Transactions of the Academy of St. Louis, vol. 3, December, 1875), that the flowers of this genus are "vespertine or nocturnal, and *proteranderous.*"

Agave yuccæfolia must be referred to Engelmann's second section, *Geminifloræ*, although on our plant the lower flowers alone are borne in pairs. The forty uppermost flowers of the spike spring singly each from the axis of a bract, and in this approach his first section, *Singulifloræ*. The production of solitary flowers on the upper portion of the spike is possibly abnormal; but should this prove a constant character a slight modification of Engelmann's sections of the genus will become necessary. In the figure in the *Botanical Magazine* the arrangement of the flowers is not distinct; but in the accompanying description we read, "Flowers *often* two together."

The scape first made its appearance on November 1st, and continued to grow until January 6th, when it had attained a height of ten feet, the first flowers opening about five P. M. on that day. Shortly after the opening of the flower the filaments attain their full development, and are exserted 9′′ beyond the lobes of the perigone. The style at this time is barely exserted and much reflexed, the stigma bearing these papillose lines radiating from its centre down the middle of each of the three lobes. A little before eight o'clock on the morning after the opening of the flower, the tube of the perigone is entirely filled with the honeyed secretion, which is slightly odoriferous, sapid, straw-colored, and very abundant. At ten P. M. of the second day, or seventeen hours after the opening of the flower, the anthers burst. At this time the style has elongated and partially straightened until the stigma, over which the papillæ have not as yet extended, is placed just above the introrse anthers, and in such a position that none of the pollen discharged from them can reach its surface. During the third day the style continues to elongate and straighten. On the morning of the fourth day the style is

found to be perfectly erect and exserted 16′′ beyond the lobes of the perigone, or 7′′ beyond the stamens at their fullest development. The papillæ have now extended laterally over the entire surface of the stigma, from which is freely secreted a clear, colorless, sticky liquid.

The stigma is now perfectly developed, and ready to receive the pollen grains;[1] but it is more than forty-eight hours since the anthers discharged their pollen, and for the last twelve they have hung useless and effete, and are already beginning to drop off. It is evident, then, that flowers of our *Agave* must depend for fertilization either on the very uncertain chance of some of the pollen discharged from the anthers of the upper flowers, dropping just at the right moment on the developed stigmas of the lower and older ones, or on the visits of some nocturnal insect, on the search for the abundant and attractive secretions contained in the tube of the perigone. Fertilization of the lower flowers is probably secured by both these agencies. Those placed higher up on the scape can only be made productive by pollen brought from other plants and placed on their stigmas at the moment of their maturity. — C. S. SARGENT.

PHYLLOTAXIS OF CONES.[2] — I wish here to supplement an article which appeared in the American Naturalist in August, 1873. Mention is there made of finding cones of several species in which the phyllotaxis of part of them consists in opposite leaves more or less spirally arranged. The fraction expressing the arrangement for scales on such cones falls into the series $\frac{2}{4}$, $\frac{2}{6}$, $\frac{4}{10}$, $\frac{6}{16}$, $\frac{10}{26}$, etc. One cone of a European larch was recorded having three, six, and nine spirals, and falling into the series $\frac{3}{6}$, $\frac{3}{9}$, $\frac{6}{15}$, $\frac{9}{24}$, $\frac{15}{39}$, etc., or having the scales in whorls of three.

This summer, on examining about three pecks of cones from one tree of the European larch, three more cones were found in which the arrangement of scales falls into the series beginning with decussate whorls of three. I have now found a single cone on which there are four spiral whorls in one direction, and four and eight in the opposite direction. The fraction expressing its phyllotaxis is $\frac{8}{24}$, and falls into the series beginning with decussating verticels of four, namely, $\frac{4}{8}$, $\frac{4}{12}$, $\frac{8}{20}$, $\frac{12}{32}$, $\frac{20}{52}$, etc. Some of these cones were exhibited with the scales marked in ink.

In reply to some questions of Professor Morse, as to whether all the cones had a phyllotaxis like the examples mentioned, Professor Beal remarked that the arrangement of most cones of the European larch was that of alternate leaves, and was expressed by the fraction $\frac{8}{21}$, falling into the series $\frac{1}{2}$, $\frac{1}{3}$, $\frac{2}{5}$, $\frac{3}{8}$, $\frac{5}{13}$, etc. The fraction for a few cones with al-

[1] I have failed to detect in *A. Yuccæfolia* any opening between the lobes of the stigma at its maturity as noticed by Engelmann in *A. Virginica*, and by Jacobi (Ag. 310) in *A. Gœppertiana*.

[2] Read in Buffalo before the American Association for 1876 by Professor W. J. Beal.

ternate leaves was $\frac{8}{29}$, falling into the series $\frac{1}{3}$, $\frac{1}{4}$, $\frac{2}{7}$, $\frac{3}{11}$, $\frac{5}{18}$, $\frac{8}{29}$, etc. In a few cones with opposite scales it was $\frac{10}{26}$, falling into a series given above. In a few others in whorls of three the fraction was $\frac{8}{15}$; in one cone the scales were in whorls of four. How many additional forms may be found on examining large numbers of specimens he did not know, but presumed we had not yet found them all. On all the trees examined, he had found the spiral whorls of the scales to vary; that certain spirals ran to the right in part of the cones, and to the left in about the same number on each tree in each year; that in all cases examined there was quite a variety in the phyllotaxis of each tree. So he had found it on many herbaceous plants.

As we might expect, there was no one, fixed, undeviating plan for the arrangement of all the leaves on plants of any species; we should find exceptions to our rules if we examine specimens enough.

Botanical Notes from Recent Periodicals. — *Flora.* (No new numbers have been received since our last review.)

Botanische Zeitung, No. 43. O. Behrendsen, Contributions to the Flora of Hungary. No. 44. E. Stahl, On the Artificial Formation of Protonemata from the Sporogonium of Musci. (In true mosses the protonema is a tubular outgrowth from the spore. This minute tube elongates by growth at the tip, and afterwards branches. Pringsheim has shown (1876) that protonematous threads may be produced from the severed fruit-stalk of mosses. This is now confirmed by Stahl, who also shows its bearing upon alternation of generation, and examines its relations to Dr. Farlow's interesting discovery of an asexual growth on the prothallus of ferns.) Cramer, Note claiming Priority of Discovery respecting Reproduction in *Ulothrix.* Reports of Societies. Nos. 45 and 46 previously noticed. No. 47. Fickel, On the Anatomy and Development of the Seed-Coats of some *Cucurbitaceæ.* Continued in Nos. 48, 49, and 50. No. 51. Dr. Drude, On the Separation of the Palms of America from those of the Old World.

ZOÖLOGY.

A New Sub-Kingdom of Animals. — Prof. E. Van Beneden in his elaborate "Recherches sur les Dicyemides, Survivants actuels d'un Embranchement des Mésozoaires" proposes a new sub-kingdom of animals. In 1830 Krohn observed the presence in the liquid bathing the spongy bodies (perhaps renal organs) of different species of Cephalopods certain filiform bodies, covered with vibratile cilia and resembling infusoria or ciliated worms. They were called *Dicyema* by Kölliker, who, with others, considered them as intestinal worms; Van Beneden claims that they have no general body-cavity. The body is formed (1) of a large axial cylindrical or fusiform cell, which extends from the anterior extremity of the body, enlarged into a head, to the caudal extremity; (2) of a single row of flat cells forming around the axial cell a sort of

simple pavement epithelium. All these cells are placed in juxtaposition like the constituent elements of a vegetable tissue. There is no trace of a homogeneous layer, of connective tissue, of muscular fibre, of nervous elements, nor of intercellular substance. There is only between the cells a homogeneous (*unissante*) substance, as between epithelial cells. The axial cell is regarded as homologous with the endoderm of the higher animals (*Metazoa*). He designates as the ectodermic layer the cells surrounding the large, single axial cell. There exists no trace of a middle layer of cells. We discover no differentiated apparatus; all the animal and vegetative functions are accomplished by the activity of the ectodermic cells and of the axial cell. On account of these characteristics Van Beneden regards these organisms as forming the type of a new branch of the animal kingdom which he distinguishes as *Mesozoa*.

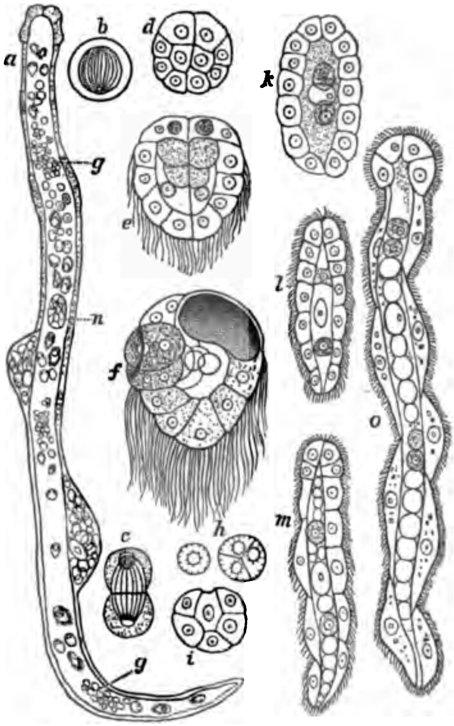
Each species of *Dicyema* comprises two sorts of individuals differing externally, one (the *Nematogene*) producing vermiform embryos, the other (*Rhombogene*) infusoriform young. The Nematogenes produce germs which undergo total segmentation, and assume a *gastrula* condition. After the closure of the blastopore the body elongates, and the worm-like form of the adult is finally attained, as they pass through the body-walls of the parent.

The germs of the Rhombogenes arise endogenously in special cells lodged in the axial cell and called "germigenes." The germ-like cells undergo segmentation, and then form small spheres which become infusoriform embryos. The worm-like young is destined to be developed and live in the Cephalopod where it has been born, while the infusorian-like young probably performs the office of disseminating the species; it transmits the parasite of one Cephalopod to another.

This work is also an important contribution to histology, particularly to the subject of cell-division. Says Van Beneden, "the recent researches of Auerbach, of Bütschli, of Strasburger, of Hertwich, and those that I have published, have established the fact that the division of a cellule, that is to say, the multiplication of the cellular individuality, is the resultant of a long series of complex phenomena, accomplished in a determinate order, and having their seat as much in the nucleus as in the substance of the cell."

Finally, Van Beneden places in his branch of *Mesozoa* the hypothetical *Gastræades*, which term he applies to (*gastrula*-like) organisms formed of two kinds of cellules, some ectodermic, others endodermic, in which the endoderm is formed by invagination. He calls *Planulades*, those hypothetical Mesozoa which are formed from a many-celled sphere constituted like a *Magosphæra* (Haeckel) and in which the two cellular layers are developed by delamination. He therefore divides the animal kingdom into three primary groups, that is, the *Protozoa*, the *Mesozoa*, and the *Metazoa*.

Our illustration will convey some idea of these organisms. Fig. *a* represents *Dicyemella wageneri*; *g*, germigenes; *n*, the nucleus of the axial cell; *b*, the spherical germ of *Dicyemella* with its striated nucleus;



(Fig. 24.) DICYEMELLA AND YOUNG.

c, the same beginning to undergo self-division; *d*, final stages of self-division (morula); *e* and *f*, infusoriform embryo; *h*, germs of the vermiform embryos of *Dicyema typus*; *i*, gastrula of the same; *k*, *l*, *m*, *o*, different stages of vermiform larvæ of *Dicyema typus*.

ANTHROPOLOGY.

Archæological Exchange Club. — A want which American anthropologists have long felt is about to be supplied in the formation ot the "Archæological Exchange Club," in connection with the "American Anthropological Association." The conditions of membership are given in a circular to be obtained from Stephen D. Peet, Secretary, Ashtabula, Ohio. The advantages to be derived by members are twofold: first, they will have their papers laid before every prominent archæologist in the country; secondly, they will be supplied with many publications which could be obtained in no other way. It is to be hoped that each one interested in this branch of science will assist in the establishment of the club by becoming a member. The benefits occurring from such

coöperation will prove great incentives to study and research. — E. A. Barber.

Anthropological News. — In the Report on Indian Affairs for 1875, Dr. Thomas Foster announces the forthcoming of a first volume of his report on all the Indian Tribes of the United States. The author has prepared an elaborate memoir on the Winnebago tribe. Pending the appearance of this volume he has commenced the issue of a sheet entitled *Foster's Indian Record and Historical Data*, the first number appearing under date of November 30th. The object of the *Record* is to submit the plan of the work to "friendly criticism" before the more costly and elaborate production appears. Fully agreeing with the author that such a work would be a worthy memorial of the race, if properly executed, we venture to offer some observations, certainly in no unfriendly spirit. The proof-reading of the *Record* is miserable; the mixing up of sundry fonts of type in the columns gives the appearance of a type-founder's circular; and the absence of literary taste detracts from the real and solid merit in the work. These, however, are venial faults, and doubtless will be rectified. The author commences his true work with the alphabet, and lays down several canons, some of which are decidedly untenable. The chief objection lies against the alphabet itself, which not only differs from Turner and Whipple's, Whitney's quoted by Gibbs, and Major Powell's in substituting new vocables for theirs, but also in calling for special fonts of type and uncommon logotypes which cannot be reproduced excepting at the printing-office where Mr. Foster's works are published. Foreign students accustomed to study the vocabularies collected by the Gibbs circular will have to re-write them for comparison. It is not necessary to take up each letter separately, since we object to the whole alphabet. The monographs will be noticed in a future number.

Those who wish a rich treat in philology will do well to read Dr. Richard Morris's presidential address before the London Philological Society, May 19, 1876. After recounting the labors of the society, and reviewing the work done on English dialects, the president called to his assistance the following specialists: Dr. J. Muir and Professor Eggeling, on Sanskrit; M. Chev. E. de Ujfalvy, on the Ugro-Finnish languages; Dr. Ad. Neubauer, on Talmudical and Rabbinical literature; the Rev. A. H. Sayce, on Etruscan; R. N. Cust, Esq., on the non-Aryan languages of India; Dr. J. Hammond Trumbull, on the North American Indian languages; M. Edouard Naville, on the latest researches of Egyptologists; Dr. Kölbing, on Teutonic languages. Dr. Trumbull, in addition to reciting the labors of those scholars with whom we are already familiar, and announcing several forthcoming works, quotes from a private letter from Major J. W. Powell, in which the following classification is recommended for the Shoshoni or Numa languages: —

Wa-shak'-i, Shoshoni proper.

Dialect: *Ta-sau'-wi-hi*, Shoshonis of Central Nevada.

Ko-man'-tsu, Comanches.
Pan-ai'-ti, Bannacks.
Pa-vi-o'-tso, Pah-Utes, or Pai Utes of Western Nevada.
Dialect: *Pan'-a-mint.*
Go-si-ute (of Nevada and Utah).
U'-ta-ats, Utes.
Dialects: *Mu-a'-tsu* (Southern California, Northern Mexico.)
Kai-vav'-it (Pai-Utes of Northern Oregon.)
Nu-a'-gun-tit (Pai-Utes of Southern Nevada.)
Tan'-ta-waits, or Chemehuevis.
Shi'-nu-mo. In six (of the seven) Pueblos in Tusayan, or Moqui, Northern Arizona.

A full account of the International Congress at Buda-Pesth will be found in Nos. 10 and 11 of the *Matériaux*. The principal part of the discussions referred to the relation between the stone and the metal age of Hungary and of the rest of Europe. Especial notice was taken of the abundance of copper articles found in Hungary.

The year just past has been rich in its gifts to classical archæology. The discoveries and published accounts of Wood at Ephesus, di Cesnola at Cyprus, Schliemann at Mycenæ, Parker at Rome, and the German explorers at Olympus are especially noticeable. Mr. Wood's results are published in Discoveries at Ephesus; Longmans & Co., 1877. Di Cesnola's latest rich harvest of gems, of jewelry and ornaments of gold, silver, and bronze, and of fictile ware, found at Kourium, on the south side of Cyprus, has been purchased for the Metropolitan Museum of Art, for the sum of $66,000. *The Academy* speaks disparagingly of our archæological students, but, no doubt, these treasures will stir up some fresh enthusiasm. Dr. Schliemann, in his excavations at Mycenæ, claims to have fallen on the tomb of Agamemnon. At least the treasure-trove proves his last discovery to be the most lucky of all, and promises to add to our knowledge of a period previously illustrated only by a few specimens in the British Museum. The fruits of the excavations at Rome may be gathered from two publications by Mr. John Murray for Mr. J. H. Parker, The Flavian Amphitheatre and Historical Construction of Walls in Rome and from The Catacombs of Rome, etc., by the Rev. W. H. Withrow: Hodder and Stoughton.

Abbé Ducrost and M. Arcelin have just finished the exploration of the detritus at the foot of the cliff at Solutré, and have found it to consist of five zones. The first, or lowest, rests on the lias and exhibits bones of extinct animals and flint flakes accumulated at points, forming kitchen-middings. The second zone contains bones of the horse, in such numbers that the individuals may be counted by hundreds of thousands. The third zone is nearly sterile. The fourth zone commences the "age of the reindeer" proper, with the refuse of cooking, and remains of dwellings, in great abundance. Here the horse and the reindeer predominate. The fifth zone is made up of modern débris. The authors

find in the results of their digging confirmation of the superposition of the Mousterian upon the Solutréan epoch, by M. G. de Mortillet.

In *Matériaux*, 11th number, Mr. Valdemar Schmidt's paper on Comparative Studies upon Funeral Rites in Prehistoric Times in Europe is reviewed. During the stone age inhumation was in use in nearly all these countries. Traces of cremation are observed in certain regions in the tombs of that age, but it can be proved that these sepultures belong to an epoch not far removed from the age of bronze. During the latter age, incineration predominated in the east of Central Europe, and in the north; but in the west inhumation was more frequent. In Scandinavian countries, two periods can be distinguished; the former, where the bodies were inhumed, the latter, where they were burned. Passing to the age of iron, anterior to the Roman period, we see inhumation practiced in Greece, cremation in Italy. In the west of Europe, inhumation predominated; in the east, incineration; in the centre, the two rites coexisted. In Scandinavia, this epoch does not exist. In the Roman epoch, they burned the corpses at Rome, in the provinces, and in most other countries; but at the end of the reign of the Antonines, inhumation was recommended, and this method was propagated everywhere, even beyond the Roman empire. Since then there has been no incineration, excepting in Slavonic countries, and among the Saxons in the north of Germany. This rite did not disappear until the prevalence of Christianity. Dr. Schmidt thinks that the custom of cremation was brought into Europe by the Aryans.

In the same number of *Matériaux*, P. Fischer contributes a very valuable paper on the recent and fossil shells found in the caverns in the south of France, and in Liguria. In gathering up these results the author has been assisted by MM. Lartet, Massenat, Mortillet, Piette, and Rivière. The authorities on the subject are copiously given.

The opening of the School of Anthropology, established a year ago in Paris, took place November 15th. M. Broca, director of the course, delivered the opening address, explaining the limits of anthropology and its relations to other subjects. Anthropology studies the individual, that it may know the many; medicine studies the many that it may heal the individual; and thus with other ancillary sciences. Anthropology is the natural history of the human race. The course, as established, is as follows: —

Anatomical Anthropology, P. Broca.
(1.) Comparison of man with the higher mammals.
(2.) Comparative anatomy of races.
(3.) Craniology.
Biological Anthropology. P. Topinard.
(1.) Physical and physiological characters of living men.
(2.) Anthropometry.
Ethnological Anthropology. Eugene Dally.

Classification of races, divisions, and relationships.

Prehistoric Anthropology. G. de Mortillet.

(1.) Human palæontology.

(2.) Prehistoric archæology.

(3.) Determination of human remains by archæological data.

Linguistic Anthropology. M. Hovelacque.

General characteristics, classification, and division of languages.

In *Archivio per l'Antropologia*, etc., Dr. Luigi Pagliani publishes an interesting memoir upon the influence of human environment upon the development of the individual, taking as his motto Quetelet's sentence, "The development of the mature man is trammeled by the special conditions in which the poor infants find themselves; the laws of nature are combated by the influences of our social organization without recurring to force. It depends in some sort upon the government to have the people large or small, more or less vigorous." M. Pagliani treats of his subject under the four following heads: —

(1.) The influence of unfavorable conditions of life on the physical development of men.

(2.) Influence of the amelioration of life upon organisms at first subjected to unfortunate conditions.

(3.) Influence of conditions somewhat favorable to life upon human physical development.

(4.) Relation between the physical development of the male and the female sex under diverse conditions.

(5.) Activity of physical development in the years which precede and follow the age of puberty in the two sexes, and under special conditions.

Five parts of Mr. Herbert Spencer's Descriptive Sociology are now in print, namely: (1.) English, (2.) Ancient American Races, (3.) Lowest Races, Negritos, Polynesians, (4.) African Races, (5.) Asiatic Races. Volume I. of The Principles of Sociology is also announced by the same author. — Otis T. Mason.

Note. In order to make the monthly anthropological notes, kindly prepared for the Naturalist by Professor Mason, as complete as possible, authors of books, pamphlets, or newspaper articles relating to anthropology, published either in this country or Europe, are invited to send copies to Prof. O. T. Mason, Columbian College, Washington, D. C. — Editor American Naturalist.

GEOLOGY AND PALÆONTOLOGY.

MM. Gaudry and De Saporta on the Palæontology of the Western Territories.[1] — I have readwith much interest the explanations in your letter relating to the explorations of the western Territories. I see that the works of Mr. Lesquereux on vegetable palæontology appear to you to be of great importance. As to myself I eagerly pursue the researches made in regard to fossil vertebrates. I think like yourself that the results of the explorations directed by Professor Hay-

[1] In a letter to Count de Saporta.

den are to be counted among the most remarkable acquisitions of modern palæontology; naturalists are compelled to recognize gratefully the labors of that great explorer who has gathered so many new facts, and who has so well understood the art of selecting such able assistants. From my stand-point, it is not the discovery of strange and hitherto unknown forms which produces the highest interest in Dr. Leidy's works on mammiferous fossils, but the discovery of the neighboring forms of our European mammiferous fossils, for they show us the ties between the species of the Old and the New World; also they let us hope that we may be able to understand and discover more easily the connections of the beings of the geological ages.

Dicotyles arcuatus looks very much like *Chæromorus* of the middle Miocene of Sausan; *Hyopsodus* has molars like the *Hyægulus* of the superior Eocene of Débruge; *Microsyops* is related to the *Adapis*, a genus partly lemurian, partly pachydermatous, which under the name of *Adapis*, sometimes under that of *Paleocolemus* and also of *Aphelotreium*, has left numerous débris in the superior Eocene, and in the lowest Miocene. *Merychippus* looks much like *Protohippus*, and the latter itself seems to be a *Hipparion* of the Leberon, the island of the superior molars of which has been transformed into a peninsula. *Archæotherium* is nothing else than the *Entelodon* of our inferior Miocene of Bouzon. Concerning dentition, *Paleosyops*, *Limnohyus*, and *Titanotherium* resemble a good deal the *Chalicotherium*; this similitude of forms has struck me the more, as it shows itself in the species, alike common in America and Europe; the *Chalicotherium* is found in Europe in the inferior Miocene of phosphorites, the middle Miocene of Sausan, and the superior Miocene of Eppelsheim. *Hyrachius* presents us a rare example of the passage from the *Lophiodon* to the tapir; concerning the distinctive marks of the latter there appears a last superior pre-molar which is simplified, and provided with one single internal denticule, like the *Lophiodon*. According to my judgment, the animal lately discovered by M. Filhol in the phosphorites of Querez, under the name of *Tapirus priscus*, is a genuine *Hyrachius*. The *Hyracodon* is one more link between the *Rhinoceros* and the *Paleotherium*; it is the former which has the dental formula of the *Paleotherium*. The *Œlurogale* of the phosphorites described by M. Filhol is the immediate ally of Dr. Leidy's *Dinictis*. There are found other examples of intermediate forms in the publications of the American savants. If we add, to judge from the plates of Dr. Leidy, the discoveries in the western Territories of the *Amphicyon*, *Canis*, *Pseudælurus*, *Mæhæcodus*, *Hyænodon*, *Hipparion*, *Anchitherium*, *Rhinoceros*, *Hyopotamus*, *Mastodon*, very closely related to the species we find in France, it becomes singularly probable that the west of North America and Europe have been in connection during the Miocene period. How could such a thing have happened, if, as able geologists believe, the Atlantic Ocean has scarcely changed its place?

Did the communication take place on the side of the Pacific? There are many mysteries still to be solved. The fine researches of American savants open new horizons for our thoughts; being so distant they still appear a little misty, but doubtless they will come forward one day and inaugurate the great era of palæontology.

Will you please, dear friend, accept the expression of my most sincere sentiments. — ALBERT GAUDRY, Professor of Palæontology in the Museum of Natural History.

Professor Hayden: Dear and Honored Sir, — For many months I have lived in communication of thought with you, and the happy intermedium of our common friend, Lesquereux, binds us to each other. Your name now is so widely known in Europe, and it is so intimately connected with the splendid discoveries which palæontologists owe to your explorations, that I have double pleasure in writing to you. We watch attentively the results of your undertaking, and, for myself, I may say that the rich harvest of Cretaceous and Tertiary fossil plants gathered under your direction have opened before me such broad horizons, that I am never tired of considering them. I have successively received the publications, reports, and fine maps recently published, — thanks to your perseverance. I offer you my most sincere wishes for the continuation of your work.

The richness of your deposits is incalculable, but it does not surprise me, and I believe that you will be able greatly to increase your treasure by new researches. Here in Europe, upon a cut-up continent which for a long time has rather been an archipelago than a wide region, we have small lacustrine formations, corresponding with other lakes of small extent, also, and these formations are often very rich in fossils. But this abundance is restricted, though real, for the extent of the formation is proportional to that of the land surface wherein they are distributed. But in America all is on a very large scale: the rivers, the plains, the lakes, the mountains, the frame itself is grand; and this aspect is the result of ancient causes which have influenced the nature and the thickness and extent of the formations.

You will therefore discover in these deposits (ours are unimportant in comparison to them) an inexhaustible mine of fossil wonders, and be able to rebuild in its integrity the transition age, from the Cretaceous to the Tertiary, a serial link destroyed in Europe by a succession of blanks.

Nevertheless in Provence even, and quite near Aix, we have a small agglomeration of what is known under the name of Lignitic of Felveau, which my friend Matheron has determined as the equivalent of the freshwater upper Cretaceous formation (Santonienne) which passes by degrees in its upper part to strata incontestably of Tertiary age. Regretfully, however, these intermediate layers which would be most interesting to know well are very barren of fossils, while the lignitic themselves have a lacustrine fluviatile fauna, and also brackish deposits extremely

rich in fossils. At a much higher level we have the gypsum of Aix, which you probably know by name at least.

I beg you will accept my highest regard and sincere devotedness. — COUNT GASTON DE SAPORTA, Aix in Provence.

MICROSCOPY.[1]

MICROSCOPICAL STRUCTURE OF AMBER. — A paper on this subject, contributed jointly by H. C. Sorby and P. J. Butler, to the Royal Microscopical Society, furnishes many interesting observations and reflections. Scattered irregularly through the masses of amber are a vast number of minute cavities, usually $\frac{1}{2000}$ to $\frac{1}{30000}$ of an inch in diameter, though some are as large as $\frac{1}{1000}$, and others probably as small as $\frac{1}{100000}$ of an inch. Though very numerous in the clouded portions of the amber, these cavities are nearly wanting in the very transparent specimens, and therefore cannot be considered a necessary result of the changes which occurred during the hardening of the balsam or resin from which the amber must have been formed. They are usually round, the shape which would be naturally assumed by drops of water or bubbles of air confined in a stiff liquid, differing in this respect from the cavities in crystals which are often spaces left vacant during the formation of the crystal, and are bounded by crystalline planes having direct relation to the form and structure of the crystal itself. The cavities in amber, however, are sometimes elongated or otherwise changed by internal movements in the resinous mass before it became hard and brittle. Some of these cavities are filled with a liquid, probably water, which differs so slightly from the amber in refractive power, that these cavities are transparent throughout a large portion of their area, the circumference being marked by a narrow, dark line. Other cavities contain gas, constituting true air bubbles, whose dark outline constitutes at least one third of their diameter, leaving a comparatively small bright spot in the centre. Still other cavities contain liquid with an inclosed air bubble; while some of the fluid cavities only seem to contain one or more air bubbles from the appearance through them of images of one or more smaller cavities beneath. Most of the cavities originally contained water, which was eliminated during the process of change from a soft balsam to a hard resin, but subsequently the water escaped from many of the cavities leaving air cavities instead, which are not only especially abundant near the natural surface of pieces of amber, but may also be found very generally close to the surfaces of sections which have been prepared and mounted for microscopical use. A comparatively rare form of cavity, and characteristic of amber, is balloon shaped, the portion representing the car being nearly always filled with water and the upper part of the balloon with air. This may have been originally a round fluid cavity, from which the gas was allowed to escape into the still plastic, surrounding

[1] Conducted by DR. R. H. WARD, Troy, N. Y.

mass by reason of diminished pressure, shrinkage in the mass having continued to occur after the external portion had become hardened into an immovable crust; a theory which is confirmed by the effects on polarized light, the central portions of the mass having no power to depolarize the light, while the marginal portions depolarize it in such manner as to indicate a strain caused by pressure in the line of the circumference and not in the line of the radius. Similarly, the black crosses seen under polarized light in certain portions of the amber, having as nuclei either air bubbles or minute solid angular bodies of a sand-like appearance, are of a character to indicate not increased but diminished pressure from within, not an expansion of the contents, or a contraction of the surrounding material upon it as is the case with minute crystals inclosed in diamonds, but a shrinkage of the contents of relatively hardened layers surrounding the bubbles or granules.

FALSE LIGHT EXCLUDER. — E. Gundlach of Rochester, N. Y., mounts his new two-inch lenses with a brass tube $\frac{5}{8}$ inch long projecting below the front surface of the objective and having a perforated diaphragm at its lower end. This cuts off much of the stray light that would otherwise enter, and still leaves $1\frac{1}{8}$ inch of working focus.

NEW OBJECTS. — The very interesting preparations of recent and fossil diatoms, by Dr. R. S. Warren, of Waltham, Mass., can now be obtained from Mr. Charles Stodder, of Boston. Many of the slides, especially those from Savannah and the Isles of Shoals, contain new or rare forms.

Charles Zentmayer, of Philadelphia, son of the well-known Joseph Zentmayer of the same city, is preparing double-stained vegetable tissues with great success. The coloring is excellently distributed and the cell peculiarity well preserved.

IDENTITY OF THE RED BLOOD CORPUSCLES IN DIFFERENT HUMAN RACES. — Dr. J. G. Richardson, of Philadelphia, well known as a leading advocate of the possibility of distinguishing by measurement the blood corpuscles of man from those of many of the familiar domestic animals, has recently extended his researches to the blood corpuscles of the different races of mankind, with a view to determine by comparative study whether they are identical or not. Taking advantage of the opportunity afforded by the International Exhibition at Philadelphia, he obtained, in some cases with considerable difficulty, permission to secure specimens of their blood from a considerable number of the members and *attachés* of the foreign commissions present at the Centennial. A finger having been suddenly pricked with a cataract needle, the top of the exuding drop of blood was touched to the centre of a glass slide, and the small drop thus obtained was spread by means of the edge of another slide, after Dr. Christopher Johnson's excellent method. In the dried film the corpuscles were measured by a cobweb micrometer whose reading, as actually employed in this work with a $\frac{1}{25}$ immersion objective of

a power of 1800, was determined by comparison with a standard of known accuracy. Only the circular disks were measured, in the thinnest part of the film, where they were least distorted in drying and most nearly in a natural condition, this method being believed to give the dimensions of the normal cell-elements more satisfactorily than can be accomplished by taking the average of the different diameters of the distorted corpuscles. So slight a deviation from a circular form as an oval having diameters of 1–3030 and 1–2857 was easily recognized, and such individuals were discarded, but all isolated circular red disks which appeared in the field were measured without selection. The measurements were recorded in fractions of an inch. Of 1400 corpuscles examined, six had a measurement of 1–4000, ten a measurement of 1–2777, and the remainder were between these two extremes. Eighty-three per cent of the whole measured from 1–3448 to 1–3030, and consequently appeared of about the same size under a power of 200. The slightly smaller averages of the Italian, Swedish, and Norwegian specimens are believed to be too small for a decisive indication of a natural difference, and the general result is believed by the author to indicate the essential identity of the different specimens studied. We have prepared the following table, which embodies all the data published in Dr. Richardson's paper in the *American Journal of Medical Science* for January, 1877: —

Nationality of Subject.	Age of Subject.	Number of Corpuscles Measured.	Average Diameter of Corpuscles.	Maximum Diameter of Corpuscles.	Minimum Diameter of Corpuscles.	Percentage of Corpuscles less than 1–3448 in Diameter.	Percentage of Corpuscles between 1–3448 and 1–3030 in Diameter.	Percentage of Corpuscles more than 1–3030 in Diameter.
Japanese	..	100	1–3212	1–2777	1–3737	8	82	10
Spanish	30	100	1–3226	1–2777	1–3571	6	89	5
Belgian	38	100	1–3203	1–2777	1–3846	7	88	5
Swiss	40	100	1–3203	1–2857	1–4000	7	82	11
Turkish	29	100	1–3197	1–2777	1–3846	4	80	16
Danish	25	100	1–3257	1–2857	1–4000	12	82	6
Russian	27	100	1–3190	1–2857	1–3571	2	91	7
Norwegian	35	100	1–3252	1–2857	1–4000	10	86	4
Swedish	33	100	1–3254	1–2777	1–3737	13	82	5
Italian	35	100	1–3272	1–2777	1–4000	10	83	7
French	67	100	1–3239	1–2777	1–3737	12	80	8
Dark mulatto, born in U. S.	52	100	1–3229	1–2857	1–3856	11	83	6
Cherokee Indian, born in U. S.	48	100	1–3215	1–2857	1–4000	10	83	7
English parentage, born in U. S.	40	100	1–3191	1–2777	1–3846	6	85	9
Total	..	1400	1–3224	1–2777	1–4000	8	83	9

SCIENTIFIC NEWS.

— Dr. Juan Gundlach, of Cuba, and Herr Leopold Krug, of Porto Rico recently spent a year in exploring the fauna of the latter island, and obtained as the result of their exertions 4 species of bats, 3 of mice, 152 birds, 22 or 23 reptiles, many fresh-water fishes, 188 marine gasteropods, 62 marine bivalves, 72 land or fresh-water Mollusca, 52 Crustacea, more than 800 Lepidoptera, including micros, 483 Coleoptera, 75 Orthoptera, 189 Hemiptera, 43 Neuroptera, 166 Hymenoptera, and 162 Diptera. They also secured some arachnids and many myriapods, as well as radiates. Herr Krug is now in Berlin with the whole collection, which will be worked up by specialists, and a general report of the whole will eventually be published.

— Among the recent publications or reprints of Messrs. D. Appleton & Co., which will be of value to naturalists as well as physicists, are the following: Arnott's Elements of Physics or Natural Philosophy. Seventh edition, edited by Alexander Bain and A. S. Taylor. New York, 1877. Prof. E. L. Youman's Class Book of Chemistry on the Basis of the New System, rewritten and revised, with many new illustrations. New York, 1876. W. G. Spencer's Inventional Geometry gives "a series of problems intended to familiarize the pupil with geometrical conceptions, and to exercise his inventive faculty." It is written by the father of Herbert Spencer. Helmholtz's Popular Lectures on Scientific Subjects have been read with the greatest interest by scientists whether biological, geological, or physical in their leanings. One's education as a naturalist will be scarcely complete until he has read the lecture On the Relation of Natural Science to Science in General, and that On the Aim and Progress of Physical Science.

PROCEEDINGS OF SOCIETIES.

Cambridge Entomological Club. — December 8, 1876. Mr. Dimmock said that in consideration of the assertion sometimes made, that female canker-moths [Anisopteryx] are occasionally carried up into trees by the males flying while in connection with them, he had made some measurements of the relative weight of the males and females, and had found that the females weigh on the average about thirty times as much as the males. These being weak-winged and slow-flying insects, it seems very improbable that the males would be able to support the weight of the females in flying through the air.

Mr. S. H. Scudder exhibited a specimen of Myrmecophila, found by Mr. H. K. Morrison in Georgia this year, this being the first specimen the capture of which in this country was authenticated. Mr. Morrison had been unable to recollect under what circumstances the specimen was collected. Dr. T. W. Harris had stated that on one occasion he found

certain soft-bodied crickets upon cucumber vines and had conjectured that they were specimens of a Myrmecophila, but there had been no confirmation of his supposition. Mr. Scudder made some further statements in regard to the Monoplistidæ, the family to which this genus belongs, and exhibited a specimen of the European species of Myrmecophila, which is found in ants' nests.

Mr. S. H. Scudder said that he was working upon a collection of fossil ants from South Park, Colorado. Heer, in his work on the fossil insects of Œningen and Radoboj, had found that most of the fossil ants discovered were winged females. It seemed reasonable that this should be so, as the winged insects were the most likely to fall into the water and be drowned, and especially the females who are much more heavy-bodied than the males. Mr. Scudder had found about forty species of ants in this collection, mostly belonging to the Formicidæ, but also to the Myrmicidæ and Poneridæ. Most of the specimens were winged females. In amber fossils most of the specimens of ants are workers.

Academy of Natural Sciences, Philadelphia. — December 19th. Mr. Meehan detailed some experiments of his own on the growth of wood, by disbarking cherry-trees in June, and watching the process. The outer series of wood cells of last year formed generating tissue from which the new season's wood was formed, the outermost layer of the new growth forming the new bark, which had no generative power. A few of these bark cells, in some instances, remained imperfect wood cells, with generative power, and from these nuclei the future protuberance was formed, the tissue continuing to reproduce and form a new layer annually as in ordinary wood growth. Instances of various kinds of growth of this character were described. The varying vital power of cells in different parts of the structure, as detailed in his remarks, were then taken to illustrate the various forms of eccentricity often noted in wood growth, as also the occasional appearance of bark within the structure and between the annual layers of wood.

SCIENTIFIC SERIALS.[1]

The Geographical Magazine. — January, 1877. The Arctic Expedition, the Results, the Outbreak of Scurvy, the Welcome Home. International Exploration of Africa; the Share of Portugal. The Abbé Desgodius on Tibet.

Annals and Magazine of Natural History. — December, 1876. New and Peculiar Mollusca of the Kellia, Lucina, Cyprina, and Corbula Families procured in the "Valorous" Expedition, by J. E. Jeffreys. List of Mollusca collected by the Rev. A. E. Eaton, at Spitzbergen, etc., determined by J. G. Jeffreys. Anatomical and Morphological Researches

[1] The articles enumerated under this head will be for the most part selected.

on the Nervous System of Hymenopterous Insects, by E. Brandt (abstract by the editors).

APPALACHIAN MOUNTAIN CLUB. — January 10th. A paper on the Flowering Plants of the White Mountains was read by Mr. J. H. Huntington.

ACADEMY OF SCIENCES. — New York, January 22d. The following papers were read: The Occurrence of Microlite in Massachusetts and North Carolina, by A. A. Julien; The Fossil Fishes of the Connecticut Valley, New Jersey, and Virginia, by Dr. J. S. Newberry; The Quartzes, Micas, and Feldspars of New York City and Vicinity.

BOSTON SOCIETY OF NATURAL HISTORY. — January 3d. Mr. J. H. Emerton made a comparison of the spiders of North America and Europe.

January 17th. — Papers were read by Dr. D. Hunt on The Closure of the first Branchial Cleft in the Mammalia; by Dr. T. M. Brewer On the Peculiar Parasitic Habits of *Molothrus Bonariensis* of South America; and by Mr. J. H. Huntington on a New Machine for making Rock-Sections.

MONTHLY MICROSCOPICAL JOURNAL. — January, 1877. On *Navicula crassinervis*, *Frustulia Saxionica*, and *Navicula rhomboides*, as Test-Objects, by W. H. Dallinger. A Stage Incubator, by H. A. Reeves. Notes on Pollen, by W. G. Smith.

QUARTERLY JOURNAL OF MICROSCOPICAL SCIENCE. — January 1877. On the Coloring Matters of Various Animals, and especially of Deep-Sea Forms dredged by H. M. S. Challenger, by H. N. Moseley. On *Stylochus Pelagicus*, a New Species of Pelagic Planarian, with Notes on other Pelagic Species, on the Larval Forms of Thysanzoon, and of a Gymnosomatous Pteropod, by H. N. Moseley. Note on a Method of preparing the Cornea, by Dr. E. Klein. Schiefferdecker's Microtome, by P. Kidd. The Minute Structure of the Gills of Lamellibranch Mollusca, by R. H. Peck. Résumé of Recent Contributions to our Knowledge of Freshwater Rhizopoda. Part III. Heliozoa and Monothalamia, compiled by William Archer. E. Schultze and Herting's Discovery of Nuclei in Foraminifera, by the Editors.

THE GEOLOGICAL MAGAZINE. — January, 1877. On Evolution in Geology, by W. J. Sollas. The Supposed Glacial Origin of Carboniferous Terraces, by J. R. Dakyns.

THE POPULAR SCIENCE REVIEW. — January, 1877. Nursing Echinoderms. (Describing Viviparous forms.)

ERRATUM. — Page 122, tenth line from bottom, for *Peruvian* read *Permian*.

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THE USE OF THE ANTENNÆ IN INSECTS.

BY L. TROUVELOT.

IT has been a question among naturalists whether the antennæ of insects were organs of touch, hearing, or smell. Notwithstanding the progress of science, our knowledge of this subject does not seem to have much advanced. While some naturalists, such as Blainville and Latreille, place the sense of smell in the antennæ, others, such as Hentz, Baster, Lehrmann, Dumeril, and Cuvier, refer it to the spiracles, Huber to the mouth, and Humboldt to different parts of the body. In a recent publication I see it stated that the antennæ are a great deal more complex than formerly supposed, and probably unite the functions of touch, hearing, and taste.

In view of this great divergence of opinion it occurred to me many years ago that experimentation would throw some light upon this subject, and I therefore began a series of experiments which I will here record.

I procured fifty or sixty living butterflies of *Limenitis Disippus* Godt. I had seen it stated that "Dr. Clemens having deprived butterflies of their antennæ, and having thrown them up, had observed that they could not fly, and fell heavily down without opening their wings." 1. I first repeated this experiment with abont a dozen individuals, all of whom; without exception, took flight, but I could observe a certain hesitation in the flight which gave less boldness and accuracy to their movements.

2. I then prepared some very thick Indian ink, and with a brush I covered carefully the eyes of several individuals, and waited until the opaque body was perfectly dried before experimenting. I let one and then another go free; they could fly, and strange as it might seem, though perfectly blind, in no case did one go blindly and hurt itself by flying against anything hard, but on the contrary they seemed to have a knowledge of the proximity of these objects, and in some cases would turn away and rest upon

some other thing. But it was noticeable that before resting, the insect acted exactly the same as uninjured individuals out-of-doors, by moving its wings, poising itself for a moment in the air in front of the object on which it had chosen to rest. A proof that the insect was perfectly blind and could not see is the fact that none of those which had their eyes covered with Indian ink were observed to fly to the single window giving light to the room where the experiments were made; if they had seen but slightly, they would have flown to the light, as all insects do in similar cases.

3. With one of these insects deprived of light I made, with a pair of scissors, and close to the head, a section of both antennæ. This insect when thrown up fell heavily down, sometimes not opening its wings at all, and was entirely unable to direct its flight.

4. I made another butterfly blind, and removed the antennæ, as in Experiment 3, and placed it at liberty upon a table, allowing it to rest a few minutes. I prepared a solution of sugar and water, and with a small brush I took up a drop of the sweet liquid, and then slowly and carefully I moved the brush very near the mouth, the head, and the spiracles, in fact all around the body. The poor blind butterfly remained perfectly still; no emanations whatever seemed to reach it from so sweet a substance. Then, guided by induction, I touched the stumps of the cut antennæ; no sooner was this done than it received the impression, unrolled its proboscis, and with great activity searched for the sweet object, in order to realize the impression it had received. For two or three minutes it was actively employed in the search, when I put before it a drop of the sweet beverage which it soon found and drank.

5. Taking another butterfly, prepared like the above, I placed on each stump of the antennæ a very small drop of thick gum arabic, and waited until it dried. This insect, thus prepared, when thrown up seemed to be without sensation, falling down like a stone, without any motion of the wings. As with the preceding butterfly, I placed it upon a table, and held the brush with the drop of sugar-water and let it touch the sealed antennal stump, but no impression was received. I also pressed the brush on the proboscis, but it was not until I had pressed so hard as to wet it through that it felt the impression and unrolled its tongue.

The following summer I made some fresh experiments upon this interesting subject. Of all the Lepidoptera with which I

am familiar in this country, the Promethea silk-worm moth is the one which in confinement will most readily accomplish the act of copulation. I have not yet found that a virgin pair on being put together did not unite the following afternoon.

6. I took several virgin pairs of this species (*Callosamia Promethea*), put each pair in a separate box, and let them remain together until they died. Each male had been deprived of its antennæ. I collected the eggs carefully; without an exception they were unfertilized, sexual union not having taken place.

Since making these experiments, it occurred to my mind that it might be objected that by cutting off the antennæ of an insect the pain resulting from such a wound would sufficiently explain the failure of a congress of the sexes. I have many times observed the sexual union of insects with one or two legs wanting, with wings half broken, etc. So, last summer, in order to test the value of this objection, I procured a certain number of virgin Promethea just out of the cocoon, and mutilated the males in different ways, some by cutting off a piece of the wings, others by the removal of a leg. These mutilated males were put with the virgin females, but notwithstanding their wounds union took place, and I raised young worms from the eggs laid by the females.

7. One afternoon I was sitting upon a rock under the shade of a tree, when my attention was attracted to a procession of a large species of ant, going from the nest to a considerable distance to gather, I think, some article of food. I contemplated in silence for some time the efforts of these industrious little laborers, when an idea crossed my mind that I had an opportunity to make one more experiment upon the use of the antennæ. I caught two or three of them, and with a small pair of scissors cut off the antennæ, and then I let them go free by the side of their busy comrades. But it was of no use; they did not seem to recognize their brothers, and did not follow the same path, but would trace a circle and turn about in every direction as if to find the route they were following before, not seeing that they had crossed it hundreds of times, and that their friends were following that same route; their eyesight was not sufficient to enable them to discover their way. After observing them for more than an hour, I found that they had not gone out of this circle when I left them.

From the second experiment I infer that when deprived of sight, insects fly with less boldness and accuracy, but they do not

blindly fly against objects, being apparently aware of their proximity. Here the faculty of sight is only an adjunct to the sense which resides in the antennæ.

In insects subjected to the first experiment, though having the power of sight, flight is deficient, the antennal sense is wanting to help the sight, and when the eyes and antennæ are rendered useless the insect is totally unable to direct its flight or to find its food. The compound eyes of insects do not seem to enable the insect to see objects at a distance, so vision is aided by another sense which has the antennæ as its organ.

In the sixth experiment the male Promethea had his sight; he could see near him another insect like himself, but his eyes alone could not tell him whether the insect was of the same species and of another sex, so he died near the object he would have desired with so much ardor if the sense organs which would have enabled him to detect the presence of the object had not been removed. So it was in the seventh experiment; the ant could see the others going on their way so intelligently, but with its eyes alone it could not recognize its friends; all were mute to him, and in the midst of friends he seemed to be in a desert.

Were I to draw any conclusion from these experiments I would say that the sense localized in the antennæ cannot be regarded only as that of touch, hearing, or taste, nor can it be regarded as uniting their complex functions. In no case have I observed insects using the antennæ as feelers; it is true they move them very rapidly when they want to recognize an object, but very seldom do the antennæ come in contact with the object; if they are feelers, they feel at a distance. With more reason they should be regarded as organs of smell, but if their functions have some analogy with the sense of smell, I think they must be very different from the sense of smell in the human species, and I would venture to say that it might have some analogy with the sense so little known though so common among animals, — with the horse, for instance, — which enables it if removed not to retrace, but find a straight line to its home, from a considerable distance, and with as much accuracy as if it could see it. So in my opinion this sense, being different from the senses common to the human species, needs a new name so as to be distinguished from and not confounded with the sense of smell. It is a kind of feeling or smelling at a great distance, by some process now totally unknown.

ABORIGINAL FUNEREAL CUSTOMS IN THE UNITED STATES.

BY EDWIN A. BARBER.

RESPECT for the dead, evinced by ceremonies, rites, or solemn decorations, has been universal in all ages and all countries. Much information can be gleaned, as to the practices of prehistoric man, from the construction of graves [1] and the relics obtained therefrom. The paleolithic and neolithic stone tools, and the later copper and bronze instruments, remain intact for centuries; but iron rusts and rapidly crumbles away, while wood decays, and all other remains of the iron age vanish in a few years, often before the particles of the human frame-work have become disintegrated. More, therefore, can be learned relative to the modes of sepulture of the anciènts than the methods of burial of much more recent tribes, and we are frequently compelled to draw conclusions in regard to the customs employed by the Indians of a century or so ago from the usages of their ancestry, since it is a well-established fact that these are handed down from generation to generation, with but few, if any, improvements or modifications. Comparatively little is known of the funereal rites of our modern savages, when we consider the great number of tribes; a fact explained by their distant removal from the centre of civilization, the secrecy of their ceremonies, and the superstition of the savage mind in regard to death. Strangers are seldom permitted to witness the disposition of Indian bodies, and nearly all such information has been obtained from subsequent grave-desecration. So far as our present knowledge extends, as regards aboriginal burial in the United States, there were four methods, namely: —

I. By inhumation (subterrene).
II. By cremation (subterrene).
III. By embalmment (subterenne).
IV. By aerial sepulture (superterrene).

The first was the one usually employed.

Bodies were interred either in ordinary graves, in mounds, or in caves. The ancient Pueblos of the Pacific slope generally practiced grave-burial. The corpse was placed three or four feet beneath the surface of the earth, and at its head were arranged food vases, ornaments, and implements of the chase. The

[1] The word *graves* in this paper is used in its broadest acceptation, including *all* places of deposit for dead bodies.

surface of the grave was level with the surrounding ground, and its dimensions were defined by stones set on edge in the soil, forming a parallelogram five or six feet in length and from two to four in breadth. The ragged edges of the slabs projected above the surface from six inches to eighteen, and occasionally a head-stone reached to the height of two feet. On none of the latter, however, has an inscription of any kind ever been observed differing in this respect from the wooden *adjedatigs* of the Dakotas.

Many interesting graves have been discovered and examined throughout the Cañon of the Rio-Mancos, in Southwestern Colorado. Captain John Moss, of that State, unearthed from one of these a perfect skull and some fragments of other bones of a human skeleton. From another he took several entire and curiously shaped vessels of pottery,[1] now in possession of Hayden's United States Geological Survey of the Territories, at Washington. It would appear from this that the deceased were supplied with vessels of food and drink to assist them on their journey to the mysterious hereafter. In addition to this custom, great quantities of pottery were strewn or broken over the surfaces of graves, in honor of the departed. Occasionally large vases or other vessels are found in a state of tolerable preservation, or, indeed, entire; these had been placed there by the friends of the deceased; but whether they were originally full of food, it is difficult to determine. In the neighborhood of Aztec Springs are long series of graves extending for miles along the valley west of the great Mesa Verde. In a particular spot, an arroyo has cut through one of these graves, showing a vertical section of it. About four feet from the level of the valley a quantity of broken pottery and charred wood may yet be seen, — the former probably at one time constituting perfect food vessels, — arranged at the head of the corpse; but the skeleton had disappeared after the exposure of many years.

Near the beginning of the Cañon of the Hovenweep, a skeleton was seen partially protruding from the eastern bank of this arroyo. It was lying about three feet below the surface, the face pointing eastward, the back of the skull only being visible. On removing it from the bank the skull fell to pieces, and but two or three of the long bones could be found, the rest of the skeleton having crumbled to dust. Sage-brush (*Artemisia*), was growing over the grave, indicating a growth of at least a hundred

[1] See Figure 12, Pl. ix., American Naturalist for August, 1876.

years, and the skeleton must have been placed there long before the vegetation commenced.

Several ancient skeletons were exhumed in the Cañon of the Montezuma in Southeastern Utah, where great numbers of graves were found. In one tomb was a portion of a skeleton, including the long bones and some of the phalanges. The skull had entirely disappeared. From another grave we took a well-preserved skull and other portions of the skeleton, all of which have been removed to Washington. This latter skull, however, is probably that of a modern Navajo. Along the valley of the Rio San Juan lies one of the most extensive aboriginal cemeteries. The graves continue uninterruptedly for several miles, and thousands of subjects were evidently here buried. The only traces of buildings are some low, circular mounds, about fifty feet in diameter, indicating the former existence of adobe structures, over which occur great quantities of broken pottery and a number of arrow-points.

Several tribes were accustomed to incase their dead in stone boxes or tombs. Among these were the Lenni Lenape, or Delawares, of Pennsylvania, although the graves already opened show an antiquity of probably not more than one hundred and fifty or two hundred years, because the native contents, consisting of fragments of rude pottery and ornaments, are associated usually with articles of European manufacture, such as glass beads, iron or copper implements, and portions of fire-arms. A number of graves have been examined in the vicinity of the Delaware Water Gap. The tumuli were scarcely distinguishable, but were surrounded by traces of shallow trenches. The skeletons lay at a depth of about three feet, and were in almost every instance inclosed in rude stone coffins. In one case the body had been placed in a slight excavation, facing the east, and above it a low mound had been built.

The second variety of inhumation was *tumulus burial*. This prevailed to a great extent among the mound builders of the Mississippi Valley. In some instances a mound contained but one body, while in others it constituted a general burial ground. The dead were generally near the original level of the surface and the mounds heaped over them. No particular posture of the body was assumed; sometimes it reclined; occasionally it was sitting, but most frequently it was extended on the back. The face was often pointed eastward, though no general rule was observed in respect to orientation.

A third method of inhumation was cave burial, such as was employed by the troglodytes of the Vézère, in Southern France. This was not common in the United States, though isolated instances are recorded, such as the remains found in the deposits of a cave in Breckenridge County, Kentucky, and also in caverns through the cañons of Utah, Arizona, and New Mexico.

Cremation was of two kinds: in graves and in urns. The former was practiced, to some extent, by the ancient Pueblos of Arizona and Utah. The body was burned and the ashes deposited in shallow tombs, marked in the ordinary way by slabs of stone set on edge around the spot. Several tribes of the Rio Gila [1] in Southern Arizona and some in Texas were in the habit of burying the bones of their departed in urns. Sometimes the skull was placed face downwards in the mouth of the vase, and served as a sort of cover or lid. In the immense cave town on the Rio de Chelly (examined by a portion of Hayden's United States Geological Survey), seven burial urns were unearthed, which had been placed in a group, their edges touching. They had been hidden just below the surface soil, on a mound of earth at the foot of the walls of the pueblo. Removing them carefully from their positions, it was found that they were about fifteen inches in height, six or seven across the mouth, made of coarse, sandy clay, and burned to a sooty blackness. The vessels were filled to the mouth with some substance, which, on examination, proved to be a white adobe cement, below which appeared fragments of charcoal, burned corn cobs, and small pieces of highly glazed pottery. No indications of charred bones were found in them, however, and it could not be determined satisfactorily whether they had originally contained sacrificial offerings merely, or whether they held human remains. At the foot of the village an extensive grave-yard was discovered, marked off into square and circular tombs by the usual upright stones. A few hundred yards beyond this, up the stream, was another extensive place of interment; so that while the latter was the usual mode of burial, it would seem as though cremation had been resorted to by the people, while the enemy was attacking the town; for it is evident that there had been a great and bloody fight here, which can be proved by the quantity of arrow points and numerous other indications.

[1] The Spaniards, as late as the sixteenth century, found some tribes in this portion of the West, which cremated their dead. Captain Fernando Alarcon, in an account of his expedition in 1540, mentions a people near the Colorado River which lived in great houses of stone and burned their corpses.

It is a matter of certainty that cremation was performed without urns; that is, bodies were burned in graves or stone tombs. At the junction of the two dry arroyos, the McElmo and the Hovenweep, a considerable community once existed. On the point of a high mesa, overlooking the water-courses for many miles to the north and south, a large burial ground was discovered, marked off by upright stones, the longest being always at the head of the grave. On opening several of these with pick and shovel, it was found that the solid bed-rock appeared at a depth of six inches to a foot and a half, so that it was impossible to have here buried any natural human bodies. It was found, on further investigation, that in each one was a quantity of black dust and some fine white powder. The majority of these graves were rectangular, but among the rest were two or three large circular *mounds*, about twenty feet each in diameter, where had probably been laid the ashes of persons of note or greater wealth. In Southwestern Colorado, the valley northeast of Ute Mountain was covered with these square inclosures, among which could be traced the foundation mounds of very ancient abodes, which had been constructed, for the most part, of clay. Among these graves we spent an entire morning, but were rewarded by the discovery of nothing except layers of fine white dust and some small fragments of burnt wood. The graves were very old, and it seemed not strange that a thousand or more years had destroyed nearly all traces of their former contents. And so in the immediate neighborhood of every considerable pueblo, we found graves more or less numerous.

From the Alta California I extract the following account as given by Mr. J. A. Parker, Superintendent of the Montezuma Canal Company of Southwestern Arizona. In speaking of the ancient ruins and human remains of Pueblo Viejo Valley, he says, "The human bones show unmistakable evidence of having been burned, and crumbled to pieces upon being handled. Several ollas (pronounced *ó-yahs*) — jug-shaped, earthern vessels, now used by the Indians for holding water — were found, which contained ashes, *small pieces of human bones*, and fragments of charcoal, which would indicate that cremation was practiced by that extinct people."

Prof. John L. LeConte describes the ceremony of cremation as performed by the Cocopa Indians of the Rio Gila, and witnessed by him in the year 1850: "A short distance from the collection of thatched huts which composed the village a shallow

trench had been dug in the desert, in which were laid logs of the mesquite (Prosopis and Strombocarpus), hard and dense wood, which makes, as all western campaigners know, a very hot fire with little flame or smoke. After a short time the body was brought from the village, surrounded by the family and other inhabitants, and laid on the logs in the trench The relatives, as is usual with Indians, had their faces disfigured with black paint, and the females, as is the custom with other savages, made very loud exclamations of grief mingled with what might be supposed to be funeral songs. Some smaller fagots were then placed on top, a few of the personal effects of the dead man added, and fire applied. After a time a dense mass of dark-colored smoke arose, and the burning of the body, which was much emaciated, proceeded rapidly. I began to be rather tired of the spectacle and was about to go away, when one of the Indians, in a few words of Spanish, told me to remain, that there was yet something to be seen.

"An old man then advanced from the assemblage with a long, pointed stick in his hand. Going near to the burning body he removed the eyes, holding them successively on the point of the stick, in the direction of the sun, with his face turned towards that luminary, repeating at the same time some words which I understood from our guide was a prayer for the happiness of the soul of the deceased. After this more fagots were heaped on the fire, which was kept up for perhaps three or four hours longer. I did not remain, as there was nothing more of interest, but I learned on inquiry that after the fire was burnt out it was the custom to collect the fragments of bone which remained, and put them in a terra-cotta vase, which was kept under the care of the family."[1]

But few cases of embalming are known to have occurred in the limits of the United States. As examples of this mode of preparing the corpse may be mentioned the Mammoth Cave and Salt Cave mummies of Kentucky. These bodies had been preserved by a rude species of embalmment and by exsiccation.

Aerial sepulture included all burial which was performed above the surface, and consisted of two kinds: the first by suspension on scaffolds or in trees, the second by sepulture in canoes. Several tribes still employ the former mode of burial. The Sioux elevate the bodies of their friends into trees, or stretch them

[1] Proceedings of the American Association for the Advancement of Science, 1874, page 41.

out on raised platforms, wrapping them in blankets and leaving them to the mercies of the elements and carnivorous birds.

Lieut. J. W. Abert tells us, in his Notes of a Military Reconnoissance in 1846, that he saw in the Arkansas bottom "several Indian bodies wrapped in blankets and skins, exposed on platforms of lodge poles, high up in cotton-wood trees, where they are safe from wolves and the sacrilegious touch of men. The air of the prairie produces rapid desiccation, and in this respect resembles Egypt and the islands of the ancient Guanches." Canoe burial is resorted to by several tribes of the Northwest. Mr. John K. Townsend, in his narrative of a journey across the Rocky Mountains, describes several such burial grounds. One, at Mount Coffin, consisted of a great number of canoes containing bodies of Indians, each being carefully wrapped in blankets, and supplied with many of his personal effects in the form of weapons and implements. Near the Columbia River was found another cemetery of this sort. The bodies were lying in canoes which had been elevated five or six feet into trees or placed on stakes. In some instances the corpses "were nailed in boxes or covered by a small canoe, which was turned bottom upwards and placed in a larger one, and the whole covered by strips of bark carefully arranged over them.

"The corpses of the several different tribes which are buried here are known by the difference in the structure of their canoes, and the *sarcophagi* of the chiefs from those of the common people by the greater care which has been manifested in the arrangement of the tomb."

Mr. Townsend also mentions another method which some of these tribes occasionally employed: "We observed to-day several high, conical stacks of drift-wood near the river. These are the graves of the Indians. Some of the cemeteries are of considerable extent, and probably contain a great number of bodies." These tombs should in all likelihood be classed with tumuli or burial mounds.

Washington Irving describes some of the same burial grounds in his Astoria, but his descriptions do not differ materially from those of Mr. Townsend.

In the Sandwich Islands, Mr. Townsend informs us, the natives practiced another mode of burial which was partially *aquatic*. Similar to a sacrificial altar, they construct what is called a *morai*. "It was the place to which the bodies of the dead chiefs were carried previous to interment. After lying here in state for a

longer or shorter time, according to the grade of rank held by the deceased, the flesh was stripped from the bones and buried in the sea; the bones were then taken and deposited in caves or subterranean vaults, which concluded the ceremony."

Aquatic burial, so far as we yet know, was not resorted to in the United States save in exceptional instances.

In regard to the Indians previously alluded to, who disposed of their dead on Mount Coffin, Mr. Irving remarks: "The same provident care for the deceased that prevails among the hunting tribes of the prairies is observable among the piscatory tribes of the rivers and sea-coast. Among the former the favorite horse of the hunter is buried with him in the same funereal mound, and his bow and arrows are laid by his side that he may be perfectly equipped for the "happy hunting grounds' of the land of spirits. Among the latter the Indian is wrapped in his mantle of skins, laid in his canoe with his paddle, his fishing-spear, and other implements beside him, and placed aloft on some rock or eminence overlooking the river, or bay, or lake that he has frequented. He is fitted out to launch away upon those placid streams and sunny lakes stocked with all kinds of fish and water-fowl, which are prepared in the next world for those who have acquitted themselves as good sons, good fathers, good husbands, and, above all, good fishermen during their mortal sojourn."

In conclusion I would state that I have simply aimed in this paper to briefly review the different forms of sepulture of the past and present aboriginal inhabitants of the United States. The article is not intended to be exhaustive, as the subject is one which would fill several volumes were it properly treated. The examples I have selected are mostly such as are comparatively new or have not as yet attracted general attention. The graves of the ancient Pueblos of the western slope have never, I believe, been accurately described.

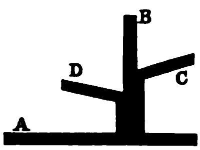
THE SLEDGE MICROTOME.

BY CHARLES SEDGWICK MINOT.

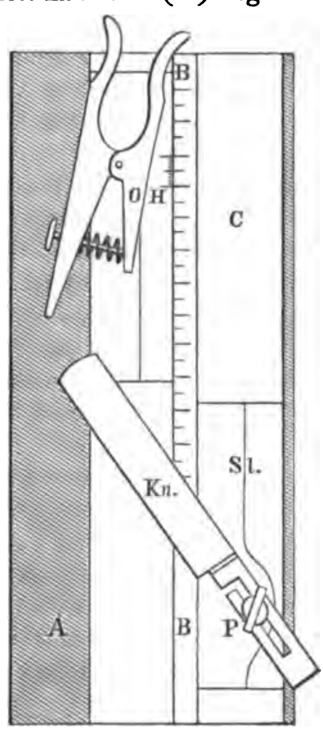
THE preparation of microscopical sections by free-hand cutting, or even with the assistance of the microtomes now in use, is accompanied by great difficulty in producing sections of even thickness. In all cases the chief trouble is caused by the irregular motion of the knife or razor which is held in the hand, and

microscopists acquire skill in cutting only by tedious practice, involving a vexatious loss of time. The instrument it is proposed to describe was invented by a French botanist to avoid this difficulty by making the guidance of the knife entirely dependent upon a mechanical construction. The instrument is so simple that two or three days suffice for learning to make sections of any desired thickness with it, while it may be used with such rapidity that hundreds of sections, all equally good, may be made in a single morning.

The instrument is made of brass, and consists of a flat, oblong base and a vertical partition (Figures 25 and 26, *B*) rising from it and running lengthwise. On each side of this partition there is a platform, that on the right-hand side (*C*) runs horizontally along the partition, and there is a sledge made to slide on it. The platform on the left-hand side (*D*) begins at one end of the partition, quite low down (Figure 25), and rises slightly but continuously as it runs along to the other end of the partition, Figure 26 (*B'*). This platform carries a sledge furnished with a clamp to hold the object to be cut. Both the platforms are oblique, as may be seen in Figure 25, so as to form together with the partition a sort of groove which is sufficient to guide the motion of the sledges perfectly. The principle of the instrument is, that the object is shoved up an inclined plane on the left-hand side, and is thereby raised. Then the knife, fastened to the sledge on the right-hand platform, is drawn back, and cuts through the object, which is then shoved a little further up the inclined plane, and the knife when drawn across cuts again in a plane parallel to that of the first cut, and thus a slice with two parallel surfaces is removed. Of course the thickness of the section is determined by



(Fig. 25.)
End view, ½, without the sledges.



(Fig. 26.)
View from above, ½.

the distance the object is moved up the inclined platform between the first and second cuts.

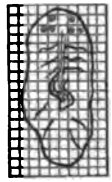
Figure 26 represents the microtome as seen from above, one half the natural size. *A*, which is shaded, represents the base; *BB'* is the top of the partition, and is marked off into millimeters, though only the centimeters are represented in the cut; on the right is the horizontal platform *C*, while the sledge (*Sl*) is represented lying on it; the sledge is provided with a screw pin (*P*) for fastening the knife, the handle of which is provided with a slot into which the pin may be slipped; the knife (*Kn*) is placed obliquely, as seen in the figure, so as to project over the other side of the partition. The sledge is made so high that the knife lies above the top of the partition. On the left-hand side of the partition is the inclined platform *D*, carrying the sledge or object holder *OH*. This carries a clamp shaped very much like one of the patent clothes-pins now so much in vogue for hanging up maps and diagrams. The object to be cut must be imbedded in paraffine or soap; it is then placed between the front arms of the clamp, where it is held tightly by the action of a spiral spring between the hind arms (compare Figure 26), so arranged as to press the front arms together.

The object holder must be slid down and the knife sledge pushed forward, and the first cut may be made by pulling the knife back. After making the cut the object is again shoved up the inclined platform a little way; the exact distance may be determined by means of the scale on the top of the partition *BB'*. The inclination of the platform is such that the slice cut off is in thickness one twentieth of the distance which the object has been shoved forward, that is, the rise is one in twenty, so that if the object be moved forward 1 m.m. the section will be $\frac{1}{20}$ m.m., and so on.

No sooner has one section been cut off than another may be made, which will be exactly parallel to the first. In this way a long object can be cut into very thin sections, all equally good, and exhibiting every part of the body cut. Now, suppose a small worm to be cut in this way into transverse sections, we could examine first the head and then the successive portions of the body. I have frequently made long series of such sections, and have found them to afford a surer means of studying the anatomy of minute opaque animals than any other I know of, for in this way every portion of the animal may be subjected to minute examination, and, further, the sections once made and mounted they

may be stowed away and investigated at any leisure moment. For example, during a few weeks at the seaside, material for a winter's occupation may be very easily procured. Neither is there so much hurry in drawing, as when an animal is living we are afraid it may die. For the sake of controlling the observations made on the sections, sketches of the general structure may be made, thus enabling the student to remember where each particular section must have come from.

There, is however, one other consideration to be noted, namely, that every cut destroys a certain amount of tissue. Thus suppose that a worm, as in Figure 27, be cut transversely, a good deal will be destroyed; but if longitudinal sections be made of another specimen, then one will see parts that the cut destroyed before, and only those spots where the two sets of cuts would have crossed had they been on the same animal will be wanting in both series. But even if you merely make a second series of cuts they will not destroy exactly the same place as in the first series.



(FIG. 27.) Longitudinal and transverse sections, the lines showing the cuts.

When only a few preparations of some tissue are wanted, this instrument permits a rapidity of work combined with a degree of nicety unattainable by any other means, and I do not hesitate to recommend it most highly both to those who are carrying on microscopical investigations and those who are forming amateur collections, for only a little care is requisite to enable even persons with unskillful or unpracticed hands to make preparations equal to the very best that have ever been produced.

To succeed in doing this, however, very great care must be paid to the way of preparing the object. The following method is applicable in a great many cases, in all, in fact, except where there is any fat to be preserved, or where, as is not unfrequently the case in histology, a special method of hardening or staining has to be employed: If the object is some small animal it may be killed by putting it in an 0.1% osmic-acid solution or in picric acid, and then in alcohol for twenty-four hours or less, according to the size of the object, and finally in absolute alcohol in sufficient quantity to entirely remove all the water from the object. For this purpose thirty or forty times the volume of the object is necessary. If the object is a bit of tissue or some organ it may be hardened in alcohol without any preliminary treatment. When the object is composed of loose tissue, and is not more than 3 m.m. in diameter, it may be colored *in toto*, thereby sav-

ing a great deal of labor. This is done by putting it after it has been in absolute alcohol in a very weak carmine or hæmatoxyline solution. Either of these may be prepared by diluting the ordinary tinctures (Beale's carmine or Bœhmer's hæmatoxyline) with about six times their volume of distilled water. Carmine usually gives the best results. The object must be left from twelve to twenty-four hours in the coloring solution, according to its size and nature, and then replaced in absolute alcohol for twenty-four hours.

It is sometimes convenient to use chromic acid for hardening tissues a little before putting them in the alcohol. In this case they cannot be easily colored *in toto* unless every trace of the chromic acid has been removed by frequently renewing the absolute alcohol, a troublesome process requiring a long time and large quantities of spirit.

The object once hardened, or colored and hardened, as the case may be, can be imbedded in paraffine by the following method: Place it in pure turpentine for half an hour, then five or ten minutes in a mixture of equal parts of paraffine and turpentine by weight, warmed so as to be liquid, and afterwards in pure, melted paraffine for five minutes. Great care must be taken not to have the paraffine warmer than is necessary to keep it liquid, otherwise the tissues will be ruined. The object should be moved about gently in the paraffine to free it from the turpentine adherent to its surface. By these processes the paraffine penetrates the whole object, giving it the best consistency possible for cutting.

The next step is to pour some paraffine into a little paper tray, then lay the object in it, and pour in enough paraffine to cover it over entirely, and leave it for half an hour or more to cool. The mass of paraffine, when solid, may be taken out, and trimmed down with a penknife to such a size and shape as will let it fit into the clamp of the object holder of the microtome; the part containing the object must project enough above the clamp to be struck by the knife as it is drawn along, in the way above described.

When the object contains fatty tissue which it is wished to examine more closely, it may be imbedded in the so-called transparent glycerine soap in the way that has already been in use for several years.

The sections when made are surrounded by paraffine, and usually curl up. They must be taken up with a fine-pointed brush,

barely moistened with spirits of turpentine, and then put on a slide and covered with a drop of turpentine, which dissolves in a few seconds all the paraffine. The sections can then be unrolled with the brush. If the object is colored *in toto*, the sections are all ready for mounting, which may be done by wiping off the superfluous turpentine with a bit of cambric. The addition of a drop of balsam (or better still of a mixture of one part Canada balsam and two parts white Dammar varnish) and putting on a cover slip complete the preparation.

If, however, the object has not been colored beforehand, the sections must be stained singly; to do this, when they have been imbedded in paraffine they must be left half an hour in a few cubic centimeters of spirits of turpentine, then one fourth of an hour in absolute alcohol, after which the alcohol should be renewed and the sections left for another quarter of an hour, whereupon they can be at once stained and mounted either in balsam or glycerine in the usual manner described in all hand-books of microscopy or histology.

This method of imbedding in paraffine has the great advantage that objects once prepared in this way may be kept indefinitely and be cut at any time, or even be partially cut, and then be stowed away to be cut again by and by, it being only necessary to cover up the exposed surface of the object by dropping a little melted paraffine upon it. I have a small collection of such objects, each one bearing a number referring to a catalogue, so that there are several things of which I can make a first-rate preparation in ten minutes at any time.

I have found it convenient in making long series of sections to designate each series by a letter of the alphabet, and after having been once through to begin anew AA, AB, AC, and then again BA, BB, BC, and so on, I am accustomed to put several sections on each slide, which are numbered. My catalogue shows what each series is, and also anything about any section I choose to note, thus: "W. Planaria tora, transverse sections, 2 (slide number) through the brain, III. (number of section) through the eyes. In this way any particular section out of many thousands can be quickly found.

The sledge microtome can be obtained of Thomas A. Upham, mechanician, 17 Harvard Place, Boston, Mass., for $25. The knives have, at present, to be imported from Windler, Dorotheenstrasse 3, Berlin C, where they cost 6 marks (2 thalers) apiece. But Mr. Upham hopes soon to be able to supply knives himself.

ON THE STUDY OF BIOLOGY.[1]

BY PROF. T. H. HUXLEY.

THE sense in which "natural history" was used at the time I am now speaking of has, to a certain extent, endured to the present day. There are now in existence, in some of our northern universities, chairs of civil and natural history, in which the term natural history is used to indicate exactly what Hobbes and Bacon meant by that term. There are others in which the unhappy incumbent of the chair of natural history is, or was, still supposed to cover the whole ground of geology and mineralogy, zoölogy, perhaps even botany, in his lectures. But as science made the marvelous progress which it did make at the end of the last and the beginning of the present century, thinking men began to discern that under this title of natural history there were included very heterogeneous constituents, — that, for example, geology and mineralogy were, in many respects, very different from botany and zoölogy; that a man might obtain an extensive knowledge of the structure and functions of plants and animals without having need to enter upon the study of geology and mineralogy, and *vice versa;* and further, as knowledge advanced, it became clear that there was a great analogy, a very close alliance, between those two sciences of botany and zoology which deal with living beings, while they are much more widely separated from all other studies. It is due to Buffon to remark that he clearly recognized this great fact. He says: "Ces deux genres d'êtres organisés (les animaux et les végétaux) ont beaucoup plus de propriétés communes que de différences réelles." Therefore it is not wonderful that at the beginning of the present century, and oddly enough in two different countries, and, so far as I know, without any intercommunication between the respective writers, two famous men clearly conceived the notion of uniting the whole of the sciences which deal with living matter into one whole, and of dealing with them as one discipline. In fact, I may say there were three men to whom this idea occurred contemporaneously, although there were but two who carried it into effect, and only one who worked it out completely. The persons to whom I refer were the eminent physiologist Bichat,[2] the great naturalist Lamarck, in France, and a distinguished

[1] Extracts from a lecture by Professor Huxley, delivered at the South Kensington Museum, on Saturday, December 16, 1876.

[2] See the distinction between the "sciences physiques" and the "sciences physiologiques" in the Anatomie Générale, 1801.

German, Treviranus. Bichat assumed the existence of a special group of "physiological" sciences. Lamarck, in a work published in 1801,[1] for the first time made use of the name "biologie," from the two Greek words which signify a *discourse upon life and living things.* About the same time it occurred to Treviranus that all those sciences which deal with living matter are essentially and fundamentally one, and ought to be treated as a whole, and in the year 1802 he published the first volume of what he also called Biologie. Treviranus's great merit consists in this, that he worked out his idea, and that he published the very remarkable book to which I refer, which consists of six volumes, and which occupied him for twenty years, — from 1802 to 1822.

That is the origin of the term "biology," and that is how it has come about that all clear thinkers and lovers of consistent nomenclature have substituted for the old confusing name of natural history, which has conveyed so many meanings, the term biology, to denote the whole of the sciences which deal with living things, whether they be animals or whether they be plants.

Having now defined the meaning of the word biology, and having indicated the general scope of biological science, I turn to my second question, which is, Why should we study biology? Possibly the time may come when that will seem a very odd question. That we, living creatures, should not feel a certain amount of interest in what it is that constitutes our life will eventually, under altered ideas of the fittest objects of human inquiry, seem to be a singular phenomenon; but at present, judging by the practice of teachers and educators, this would seem to be a matter that does not concern us at all. I propose to put before you a few considerations which I dare say many of you will be familiar with already, but which will suffice to show — not fully, because to demonstrate this point fully would take a great many lectures — that there are some very good and substantial reasons why it may be advisable that we should know something about this branch of human learning. I myself entirely agree with another sentiment of the philosopher of Malmesbury, that "the scope of all speculation is the performance of some action or thing to be done," and I have not any very great respect for or interest in mere knowing as such. I judge of the value of human pursuits by their bearing upon human interests, — in other

[1] Hydrogéologie, an. x., 1801.

words, by their utility; but I should like that we should quite clearly understand what it is that we mean by this word "utility." Now, in an Englishman's mouth, it generally means that by which we get pudding or praise, or both. I have no doubt that is one meaning of the word utility, but it by no means includes all I mean by utility. I think that knowledge of every kind is useful in proportion as it tends to give people right ideas, which are essential to the foundation of right practice, and to remove wrong ideas, which are the no less essential foundations and fertile mothers of every description of error in practice. And, upon the whole, inasmuch as this world is, after all, whatever practical people may say, absolutely governed by ideas, and very often by the wildest and most hypothetical ideas, it is a matter of the very greatest importance that our theories of things, and even of things that seem a long way apart from our daily lives, should be as far as possible true, and as far as possible removed from error. It is not only in the coarser practical sense of the word utility, but in this higher and broader sense, that I measure the value of the study of biology by its utility, and I shall try to point out to you that you will feel the need of some knowledge of biology at a great many turns of this present nineteenth-century life of ours. For example, most of us lay great and very just stress upon the conception which is entertained of the position of man in this universe, and his relation to the rest of nature. We have almost all of us been told, and most of us hold by the tradition, that man occupies an isolated and peculiar position in nature; that though he is in the world he is not of the world; that his relations to things about him are of a remote character, that his origin is recent, his duration likely to be short, and that he is the great central figure round which other things in this world revolve. But this is not what the biologists tell us. At the present moment you will be kind enough to separate me from them, because it is in no way essential to my argument just now that I should advocate their views. Don't suppose that I am saying this for the purpose of escaping the responsibility of their beliefs, because at other times and in other places I do not think that point has been left doubtful; but I want clearly to point out to you that for my present argument they may all be wrong; nevertheless, my argument will hold good. The biologists tell us that all this is an entire mistake. They turn to the physical organization of man. They examine his whole structure, his bony frame, and all that clothes it. They resolve him into the finest particles

into which the microscope will enable them to break him up. They consider the performance of his various functions and activities, and they look at the manner in which he occurs on the surface of the world. Then they turn to other animals, and, taking the first handy domestic animal, — say a dog, — they profess to be able to demonstrate that the analysis of the dog leads them in gross to precisely the same results as the analysis of the man; that they find almost identically the same bones, having the same relations; that they can name the muscles of the dog by the names of the muscles of the man, and the nerves of the dog by those of the nerves of the man, and that such structures and organs of sense as we find in the man, such also we find in the dog; they analyze the brain and spinal cord, and find the nomenclature which does for the one answer for the other. They carry their microscopic inquiries in the case of the dog as far as they can, and they find that his body is resolvable into the same elements as those of the man. Moreover, they trace back the dog's and the man's development, and they find that at a certain stage of their existence the two creatures are not distinguishable the one from the other; they find that the dog and his kind have a certain distribution over the surface of the world comparable in its way to the distribution of the human species. What is true of the dog they tell us is true of all the higher animals; and they find that for the whole of these creatures they can lay down a common plan, and regard the man and the dog, the horse and the ox, as minor modifications of one great fundamental unity. Moreover, the investigations of the last three quarters of a century have proved, they tell us, that similar inquiries carried out through all the different kinds of animals which are met with in nature will lead us, not in one straight series, but by many roads, step by step, gradation by gradation, from man at the summit to specks of animated jelly at the bottom of the series; so that the idea of Leibnitz and of Bonnet, that animals form a great scale of being in which there is a series of gradations from the most complicated form to the lowest and simplest, — that idea, though not exactly in the form in which it was propounded by those philosophers, turns out to be substantially correct. More than this, when biologists pursue their investigations into the vegetable world, they find that they can in the same way follow out the structure of the plant from the most gigantic and complicated trees through a similar series of gradations until they arrive at similar specks of animated jelly, which they are puzzled to distinguish from those which they reached by the animal road.

Thus they have arrived at the conclusion that a fundamental uniformity of structure pervades the animal and vegetable worlds, and that plants and animals differ from one another simply as modifications of the same great general plan.

Again, they tell us the same story in regard to the study of function. They admit the large and important interval which, at the present time, separates the manifestations of the mental faculties observable in the higher forms of mankind, and even in the lower forms, such as we know them, mentally from those exhibited by other animals; but, at the same time, they tell us that the foundations or rudiments of almost all the faculties of man are to be met with in the lower animals; that there is a unity of mental faculty as well as of bodily structure, and that here also the difference is a difference of degree and not of kind. I said "almost all" for a reason. Among the many distinctions which have been drawn between the lower creatures and ourselves, there is one which is hardly ever insisted on,[1] but which may be fitly spoken of in a place so largely devoted to art as that in which we are assembled. It is this, that while among various kinds of animals it is possible to discover traces of all the other faculties of man, especially the faculty of mimicry, yet that particular form of mimicry which shows itself in the imitation of form, either by modeling or by drawing, is not to be met with. As far as I know, there is no sculpture or modeling, and decidedly no painting or drawing of animal origin. I mention the fact in order that such comfort may be derived therefrom as artists may feel inclined to take.

If what the biologists tell us is true, it will be needful for us to get rid of our erroneous conceptions of man and of his place in nature, and substitute for them right ones.

Granted that biology is something worth studying, what is the best way of studying it? Here I must point out that, since biology is a physical science, the method of studying it must needs be analogous to that which is followed in the other physical sciences. It has now long been recognized that if a man wishes to be a chemist it is not only necessary that he should read chemical books and attend chemical lectures, but that he should actually himself perform the fundamental experiments in the laboratory, and know exactly what the words which he finds in his books and hears from his teachers mean. If he does not do that, he may read till the crack of doom, but he will never know

[1] I think that Professor Allman was the first to draw attention to it.

much about chemistry. That is what every chemist will tell you, and the physicist will do the same for his branch of science. The great changes and improvements in physical and chemical scientific education which have taken place of late have all resulted from the combination of practical teaching with the reading of books and with the hearing of lectures. The same thing is true in biology. Nobody will ever know anything about biology, except in a dilettant "paper-philosopher" way, who contents himself with reading books on botany, zoölogy, and the like; and the reason of this is simple and easy to understand. It is, that all language is merely symbolical of the things of which it treats; the more complicated the things, the more bare is the symbol, and the more its verbal definition requires to be supplemented by the information derived directly from the handling, and the seeing, and the touching of the thing symbolized: that is really what is at the bottom of the whole matter. It is plain common sense, as all truth in the long run is, only common sense clarified. If you want a man to be a tea-merchant, you don't tell him to read books about China or about tea, but you put him into a tea-merchant's office, where he has the handling, the smelling, and the tasting of tea. Without the sort of knowledge which can be gained only in this practical way, his exploits as a tea-merchant will soon come to a bankrupt termination. The paper-philosophers are under the delusion that physical science can be mastered as literary accomplishments are acquired, but unfortunately it is not so. You may read any quantity of books, and you may be almost as ignorant as you were at starting if you don't have, at the back of your minds, the change for words in definite images which can only be acquired through the operation of your observing faculties on the phenomena of nature.

It may be said: "That is all very well, but you told us just now that there are probably something like a quarter of a million different kinds of living and extinct animals and plants, and a human life could not suffice for the examination of one fiftieth part of all this." That is true, but then comes the great convenience of the way things are arranged; which is, that, although there are these immense numbers of different kinds of living things in existence, yet they are built up, after all, upon marvelously few plans.

There are, I suppose, about 100,000 species of insects, if not more, and yet anybody who knows one insect — if a properly

chosen one — will be able to have a very fair conception of the structure of the whole. I do not mean to say he will know that structure thoroughly, or as well as it is desirable he should know it, but he will have enough real knowledge to enable him to understand what he reads, to have genuine images in his mind of those structures which become so variously modified in all the forms of insects he has not seen. In fact, there are such things as types of form among animals and vegetables, and for the purpose of getting a definite knowledge of what constitutes the leading modifications of animal and plant life it is not needful to examine more than a comparatively small number of animals and plants.

Let me tell you what we do in the biological laboratory in the building adjacent to this. There I lecture to a class of students daily for about four and a half months, and my class have, of course, their text-books; but the essential part of the whole teaching, and that which I regard as really the most important part of it, is a laboratory for practical work, which is simply a room with all the materials arranged for ordinary dissection. We have tables properly arranged in regard to light, microscopes, and dissecting instruments, and we work through the structure of a certain number of animals and plants. As, for example, among the plants we take a yeast plant, a *Protococcus*, a common mould, a *Chara*, a fern, and some flowering plant; among the animals, we examine such things as an amœba, a *Vorticella*, and a fresh-water polyp. We dissect a star-fish, an earth-worm, a snail, a squid, and a fresh-water mussel. We examine a lobster and a craw-fish and a black beetle. We go on to a common skate, a cod-fish, a frog, a tortoise, a pigeon, and a rabbit, and that takes us about all the time we have to give. The purpose of this course is not to make skilled dissectors, but to give every student a clear and definite conception, by means of sense-images, of the characteristic structure of each of the leading modifications of the animal kingdom; and that is perfectly possible, by going no further than the length of that list of forms which I have enumerated. If a man knows the structure of the animals I have mentioned, he has a clear and exact, however limited, apprehension of the essential features of the organization of all those great divisions of the animal and vegetable kingdoms to which the forms I have mentioned severally belong. And it then becomes possible for him to read with profit, because, every time he meets with the name of a structure, he has a definite image in his mind of what the

name means in the particular creature he is reading about, and therefore the reading is not mere reading. It is not mere repetition of words; but every term employed in the description, we will say, of a horse or of an elephant, will call up the image of the things he had seen in the rabbit, and he is able to form a distinct conception of that which he has not seen as a modification of that which he has seen.

I find this system to yield excellent results, and I have no hesitation whatever in saying that any one who has gone through such a course attentively is in a better position to form a conception of the great truths of biology, especially of morphology (which is what we chiefly deal with), than if he had merely read all the books on that topic put together.

The connection of this discourse with the Loan Collection of Scientific Apparatus arises out of the exhibition in that collection of aids to our laboratory work. Such of you as have visited that very interesting collection may have noticed a series of diagrams and of preparations illustrating the structure of a frog. Those diagrams and preparations have been made for the use of the students in the biological laboratory. Similar diagrams and preparations, illustrating the structure of all the other forms of life we examine, are either made or in course of preparation. Thus the student has before him, first, a picture of the structure he ought to see; secondly, the structure itself worked out; and if, with these aids, and such needful explanations and practical hints as a demonstrator can supply, he cannot make out the facts for himself in the materials supplied to him, he had better take to some other pursuit than that of biological science.

I should have been glad to have said a few words about the use of museums in the study of biology, but I see that my time is becoming short, and I have yet another question to answer. Nevertheless, I must, at the risk of wearying you, say a word or two upon that important subject of museums. Without doubt, there are no helps to the study of biology, or rather to some branches of it, which are or may be more important than natural-history museums; but, in order to take this place in regard to biology, they must be museums of the future. The museums of the present do not do by any means so much for us as they might do. I do not wish to particularize, but I dare say many of you seeking knowledge, or in the laudable desire to employ a holiday usefully, have visited some great natural-history museum. You have walked through a quarter of a mile of animals well

stuffed, with their long names written out underneath them; and, unless your experience is very different from that of most people, the upshot of it all is that you leave that splendid pile with sore feet, a bad headache, and a general idea that the animal kingdom is a mighty maze without a plan. I do not think that a museum which brings about this result has done all that may reasonably be expected of such an institution. What is needed in a collection of natural history is, that it should be made as accessible and as useful as possible on the one hand to the general public, and on the other to scientific workers. That need is not met by constructing a sort of happy hunting ground of miles of glass cases, and, under the pretense of exhibiting everything, putting the maximum amount of obstacles in the way of those who wish properly to see anything.

What the public want is easy and unhindered access to such a collection as they can understand and appreciate; and what the men of science want is similar access to the materials of science. To this end the vast mass of objects of natural history should be divided into two parts, — one open to the public, the other to men of science, every day, and all day long. The former division should exemplify all the more important and interesting forms of life. Explanatory tablets should be attached to them, and catalogues, containing clearly written expositions of the general significance of the objects exhibited, should be provided. The latter division should contain, packed into a comparatively small space, the objects of purely scientific interest. For example, we will say I am an ornithologist. I go to see a collection of birds. It is a positive nuisance to have them stuffed. It is not only sheer waste, but I have to reckon with the ideas of the bird stuffer, while if I have the skin and nobody has interfered with it, I can form my own judgment as to what the bird was like. For ornithological purposes, what is needed is not glass cases full of stuffed birds on perches, but convenient drawers, into each of which a great quantity of skins will go. They occupy no great space, and do not require any expenditure beyond their original cost. But, for the purpose of the public, who want to learn, indeed, but do not seek for minute and technical knowledge, the case is different. What one of the general public, walking into a collection of birds, desires to see, is not all the birds that can be got together; he does not want to compare a hundred species of the sparrow tribe side by side; but he wishes to know what a bird is, and what are the great modifications of bird structure,

and to be able to get at that knowledge easily. What will best serve his purpose is a comparatively small number of birds, carefully selected, and artistically as well as accurately set up, with their different ages, their nests, their young, their eggs, and their skeletons side by side, and, in accordance with the admirable plan which is pursued in this museum, a tablet, telling the spectator, in legible characters, what they are and what they mean. For the instruction and recreation of the public, such a typical collection would be of far greater value than any many-acred imitation of Noah's ark.

Lastly comes the question as to when biological study may best be pursued. I do not see any valid reason why it should not be made, to a certain extent, a part of ordinary school training. I have long advocated this view, and I am perfectly certain that it can be carried out with ease, and not only with ease, but with very considerable profit to those who are taught; but then such instruction must be adapted to the minds and needs of the scholars. They used to have a very odd way of teaching the classical languages when I was a boy. The first task set you was to learn the rules of the Latin grammar in the Latin language, — that being the language you were going to learn. I thought then that this was an odd way of learning a language, but did not venture to rebel against the judgment of my superiors. Now, perhaps, I am not so modest as I was then, and I allow myself to think it was a very absurd fashion. But it would be no less absurd if we were to set about teaching biology by putting into the hands of boys a series of definitions of the classes and orders of the animal kingdom, and making them repeat them by heart. That is a very favorite method of teaching, so that I sometimes fancy the spirit of the old classical system has entered into the new scientific system, in which case I would much rather that any pretense at scientific teaching were abolished altogether. What really has to be done is to get into the young mind some notion of what animal and vegetable life is. You have to consider in this matter practical convenience as well as other things. There are difficulties in the way of a lot of boys making messes with slugs and snails; it might not work in practice. But there is a very convenient and handy animal which everybody has at hand, and that is himself; and it is a very easy and simple matter to obtain common plants. Hence, the broader facts of anatomy and physiology can be taught to young people in a very real fashion by dealing with

the broad facts of human structure, such as hearts, lungs, and livers. Such viscera as they cannot very well examine in themselves may be obtained from the nearest butcher's shop. In respect to teaching them something about the biology of plants, there is no practical difficulty, because almost any of the common plants will do, and plants do not make a mess, — at least they do not make an unpleasant mess; so that, in my judgment, the best form of biology for teaching to very young people is elementary human physiology on the one hand, and the elements of botany on the other; beyond that I do not think it will be feasible to advance for some time to come. But then I see no reason why in secondary schools, and in the science classes, which are under the control of the science and art department — and which, I may say, in passing, have, in my judgment, done so very much for the diffusion of a knowledge over the country — I think that, in those cases, we may go further, and we may hope to see instruction in the elements of biology carried out, not, perhaps, to the same extent, but still upon somewhat the same principle, as we do here. There is no difficulty, when you have to deal with students of the ages of fifteen or sixteen, in practicing a little dissection and getting a notion, at any rate, of the four or five great modifications of the animal form, and the like is true in regard to plants.

While, lastly, to all those who are studying biological science with a view to their own edification, or with the intention of becoming zoölogists or botanists; to all those who intend to pursue physiology — and especially to those who propose to employ the working years of their lives in the practice of medicine — I say that there is no training so fitted, or which may be of such important service to them, as the thorough discipline in practical biological work which I have sketched out as being pursued in the laboratory hard by.

I may add that, beyond all these different classes of persons who may profit by the study of biology, there is yet one other. I remember, a number of years ago, that a gentleman who was a vehement opponent of Mr. Darwin's views, and had written some terrible articles against them, applied to me to know what was the best way in which he could acquaint himself with the strongest arguments in favor of evolution. I wrote back in all good faith and simplicity, recommending him to go through a course of comparative anatomy and physiology, and then to study development. I am sorry to say he was very much displeased, as

people often are with good advice. Notwithstanding this discouraging result, I venture, as a parting word, to repeat the suggestion, and to say to all the more or less acute lay and clerical paper-philosophers [1] who venture into the regions of biological controversy: Get a little sound, thorough, practical, elementary instruction in biology.

ON THE PEOPLING OF AMERICA.

BY AUG. R. GROTE.[2]

THE conclusion was first reached by myself in a paper [3] read before the American Association, August, 1875 (since reprinted in several journals), that we should find colonies of Arctic man upon mountains in the temperate zone of North America, had all the conditions for his survival on these elevations been fulfilled in his case as they have been in that of certain plants and animals. That the Eskimos are the existing representatives of the man of the American Glacial epoch, just as the White Mountain butterfly (*Oeneis semidea*) is the living representative of a colony of the genus planted on the retiring of the ice from the valley of the White Mountains, seemed to me at that time a natural conclusion. In a subsequent paper,[4] Dr. C. C. Abbott, basing his remarks on paleolithic implements discovered by himself in New Jersey, says: "It is fair to presume that the first human beings that dwelt along the shores of the Delaware were really the same people as the present inhabitants of Arctic America." The title of Dr. Abbott's paper is Traces of an American Autochthon, and in it he institutes a comparison of the paleolithic implements of New Jersey with those of Southern France. According to a foot-note of Dr. Abbott's it appears that in 1875 Dr. Rink [5] was "strongly of opinion that the Eskimo are an

[1] Writers of this stamp are fond of talking about the Baconian method. I beg them, therefore, to lay to heart these two weighty sayings of the herald of Modern Science: —

"Syllogismus ex propositionibus constat, propositiones ex verbis, verba notionum tesseræ sunt. Itaque si notiones ipsæ (*id quod basis rei est*) confusæ sint et temere a rebus abstractæ, nihil in iis quæ superstruuntur est firmitudinis." — Novum Organon ii. 14.

"Huic autem vanitati nonnulli ex modernis summa levitate ita indulserunt, ut in primo capitulo Geneseos et in libro Job et aliis scripturis sacris, philosophiam naturalem fundare conati sint; *inter vivos quærentes mortua*." — Ibid. 65.

[2] Read before the Buffalo Society of Natural Sciences, February 2, 1877.

[3] Effect of the Glacial Epoch upon the Distribution of Insects in North America, Proc. Am. Assoc. Adv. Sci., Detroit Meeting, B. Natural History, 225.

[4] Am. Nat., June, 1876, 329.

[5] Tales and Traditions of the Eskimo, London, 1875.

indigenous American people who have been pushed northwards by the intrusive Indian tribes." A note of mine in objection to the idea that paleolithic man in North America is an "autochthon" will be found in The American Naturalist for July, 1876, p. 432.

It will be seen that, independently of each other and from different stand-points, the fact that we have in the Eskimo a survival of paleolithic man in North America has been arrived at by Dr. Abbott and, previously, by myself. The subsequent discovery by Professor Dana[1] of remains of the reindeer in glacial deposits in the valley of the Connecticut, and the determination of the beds in which the rough stone implements were found as ancient moraines, help to assign a geological age to the presence of man in North America, as well as to give a picture of his surroundings. I have endeavored to carry out the original idea which I entertained, that glacial man would be found to have suffered an equal fate with the fauna of the Ice period, by a study of migrations.

In a lecture delivered in the course of the Buffalo Society of Natural Sciences[2] January 6, 1877, I published the conclusions arrived at, already briefly sketched in my note in The American Naturalist for July of the preceding year. I proposed to distinguish: "A *primitive* migration, one influenced solely by physical causes affecting man's existence, and which must have been in more extensive operation in early times when he was unprovided with means of his own invention against unfriendly changes in his surroundings. Such migrations, or a modified survival of them, are operative now among our Indians, who move from place to place with the game upon which they subsist and with the season. A *culture* migration, one arising out of a certain stage of intellectual advancement when the movements of man are determined by ultimate and not immediate considerations. The movements of the Indo-European races fall within this category. Besides these is to be distinguished an *accidental* migration, which man has submitted to against his will. The accidental migrations of man may be considered as belonging to the epochs of culture migration, since they must more usually have occurred with races advanced in the art of navigation. A separation of individuals from communities under the pressure of storms, earthquakes, volcanic eruptions, etc., may have happened, however, in the earliest times."

[1] Am. Jour. Sci. Arts, 353, November, 1875.
[2] Buffalo Courier, January 7, 1877.

It will be seen that I differ from Dr. Abbott by considering the presence of the progenitors of the Eskimo over the main belt of this continent during the Ice period as due to "a primitive and unconscious migration determined by the shifting of their congenial surroundings." It does not appear that Dr. Rink couples the migration of the Eskimo with the movement of the ice over this continent. Indeed, his idea seems opposed to this, and does not imply any relation between the Eskimo and the Ice period.

These discoveries and considerations open up the question of Tertiary man. It is certain, as I have elsewhere suggested, that man could not have originated at the foot of the glacier. The ice must have met him, towards the close of the Tertiary, in the northern parts of Asia and America and forced him southward; or, at a later time, it must have found him on the main belt of this continent. The Tertiary origin of man is presupposed from the fact that he had submitted to a race modification fitting him to endure the cold. Some support for these ideas may be found in examining northern strata; it must be borne in mind, however, that the north has never been free from ice since the close of the Pliocene to this day.

It would appear more sensible, in view of the present ascertained facts of science, that for the original Tertiary form of man we should search a territory inhabited at that time by animals the nearest related to him. Considerations of this kind will prevent us from entertaining the belief that man originated in America. We must still believe that America has always been for man the New World.

If we turn to the detached Antarctic lands, covered by glaciers descending to form an ice wall along their coasts, to be fretted away by the beating of the ocean waves, we see that other sciences may be advanced by their exploration, but anthropology only indirectly. In February, 1842, Ross reached the most southern point yet attained, lat. 78° 11′, long. 161° 27′W., and it is strange that both he and Weddell[1] report an open sea before them to the south, as Kane did to the north.

So soon as Arctic America is explored by means of the establishment of permanent stations of observation, akin to that in operation on Mount Washington, a system recently recommended in this country as well as in Europe, important data as to the introduction of man on this continent cannot fail to be brought to light. The establishment of an international scien-

[1] Neumayer, Zeits. Ges. Erdk., 1872.

tific service for the observation of astronomical, meteorological, geological, and zoölogical phenomena commends itself at the present time to the more civilized powers. The different governments established by the white races should contribute their quota of the expenses for the establishment and maintenance of posts of observation in different localities over the globe, to be decided upon by commissions of specialists. In time of war such posts should be held neutral, as well as their service, under a flag and protected by the operation of international law. In the case of the Arctic regions, Great Britain, the United States, Russia, and Scandinavia are the more interested from their geographical position; yet other powers are directly interested in the solution of the different problems which will be offered though the knowledge of those parts of the earth's surface. In Madagascar we must also expect some evidence to be forthcoming with reference to the origin of man. A definite settlement of the latter question can be arrived at if evolution be true. Is not this a question to call for the active interest of the cultivated races? Its settlement would greatly advance our material interests as a species by giving us a mental habit in accordance with the facts in the case. I think that the prospect alone of arriving at a solution of this question should prompt concerted action, either by a scientific service or such other means as experience may prefer.

When we examine into the question of the stone implements, which prove the fact of the presence of man, we must see that the earlier man must have first used a stone as he found it. "There must have been a time when men picked up such stones as came in their way at the moment with which to throw at animals, to break their food, to injure their fellow men. Such stones, unaltered by use, can no longer be identified." There will be an imperfection here in the record from implements.

The difficulty of supposing man to have been first introduced into America during the Quarternary period lies in the fact that he must have been in the Stone age when the migration was made. This difficulty vanishes if, as I suppose, man entered upon possession of this continent during the Pliocene and before the Ice period had interfered with a warm climate in the north. This will leave us free to consider American civilizations indigenous. The idea is here suggested that the Ice period acted as a barrier to inter-communication ... ia and ... merica. The part allowed hitherto ... ists ... migration

in the peopling of North America will be found, I think, exaggerated. We may conceive that this peopling was effected during the Tertiary; that the ice modified races of Pliocene man, existing in the north of Asia and America, forced them southward, and then drew them back to the locality where they had undergone their original modification. Also, we may suggest that other than Arctic man may have existed across the main belt of this continent during the Pliocene, and that his subsequent intellectual development, as we find it recorded in the West, Mexico, and South America, etc., is the result of his environment acting upon his isolated condition.

The object of the present paper is to call attention to this hypothesis, which must be studied from the point of view that man's earlier migrations were not distinguishable in kind from those of lower animals. It seems to me quite evident that, at a time when instinct was developing into reason, the migrations of man must have had a motive which was not far removed from that influencing certain lower animals under the same circumstances. If we concede this, it follows that the objects of man's primitive migrations were more immediate, and of his culture migrations more remote. This one fact, that the distribution of man over the surface of the globe is more general than that of any other animal, will support the view that, through the fertility of his resources, he has been able to outgrow the limitations originally imposed upon him. But these resources must have been brought into play by experience; and their cost was surely the premature perishment of many of the kind.[1] During the process, then, which resulted in the race modification of the Eskimos, their original numbers must have been decreased by the slowly but ever increasing cold of the northern regions, until experience and physical adaptation combined brought them to a state of comparative stability as a race.

We must also consider that the farther back we go the nearer we must come to a common race of man, supposing the theory of the essential unity of his origin to be true, while I think the probable effect of the Ice period upon climate and the present development of man has not been hitherto sufficiently considered. The entire environment must be taken into consideration,

[1] Many birds witness the death of their companions by the hunter with indifference when first discovered by man, but afterwards, from observation, avail themselves of all their natural means to escape from the danger. It is possible that it was not difficult for Tertiary man to supply himself with animal food even with his imperfect weapons.

however complex it is and at whatsoever cost to us the knowledge of it is to be attained, before we can grasp the true picture of the succession of events which have resulted in man as we now find him on the different lands of the globe. With the thinking minds of our race, the question of the origin of man is the question of the century.

The hypotheses as to the manner in which the early peoplings of America were effected, developed in the present and previous papers of mine, are as follows: —

(1.) That during the Tertiary period man had spread from Equatorial lands on the eastern hemisphere to Northern Asia, and had then crossed into America from the North.

(2.) That in at least as early as Pliocene time man had migrated down the high lands adjacent to the mountainous backbone running along the western side of the two Americas.

(3.) That the Ice-period produced a race modification of the man living in the extreme north, and that the advance of the ice prevented further communication between the Old and the New Worlds until comparatively recent times.

(4.) That this race accompanied the great glacier on its advance and retirement over North American territory, and that the existing representatives of this race are the Eskimos.

THE POLAR COLONIZATION PLAN.

BY CAPT. H. W. HOWGATE, U. S. N.

THE expeditions of Captain Hall in the Polaris, in 1871, and of Captain Nares in the Alert and Discovery, in 1875, have shown that by the use of steam it is a comparatively easy matter to reach the entrance to Robeson's Channel in latitude 81° north, and that the serious difficulties to be overcome in reaching the Pole lie beyond that point. Parties from the two expeditions have made fair surveys one hundred and forty miles north of this, leaving only about four hundred miles of unexplored region between that and the goal of modern geographers, — the Pole.

When Captain Hall reached the upper extremity of Robeson's Channel the lookout of the Polaris reported open water in sight and just beyond the pack which surrounded the vessel and prevented further progress. This open water was afterwards seen from the cape at the northern opening of Newman's Bay, and it

was the opinion of the crew of that ill-fated vessel that if she had been but the fraction of an hour earlier in reaching the channel they could have steamed unobstructed over a veritable "open sea" to the Pole itself. We know that they did not succeed, but were forced to winter almost within sight of this sea, and subsequently, disheartened by the loss of their gallant commander, abandoned the enterprise.

Where this open water was found, Captain Nares in 1875 and 1876 found solid, impenetrable ice, through which no vessel could force its way, and over which it was equally impossible for sledge parties to work.

These facts appear to show that within the Arctic circle the seasons vary as markedly as in more temperate southern latitudes, and that the icy barriers to the Pole are sometimes broken up by favoring winds and temperature. To reach the Pole prompt advantage must be taken of such favoring circumstances, and to do this with the greatest certainty and with the least expenditure of time, money, and human life, it is essential that the exploring party be on the ground at the very time the ice breaks up and opens the gate-way to the long-sought prize. This can be done only by colonizing a few hardy, resolute, and experienced men at some point near the borders of the Polar Sea, and the most favorable one for the purpose appears to be that where the Discovery wintered last year.

Such a party should consist of at least fifty men, and should be provided with provisions and other necessary supplies for three years, at the end of which period they should be visited, and if still unsuccessful in accomplishing the object, revictualled and again left to their work. Captain Hall spent eight years among the Esquimaux, and each year found himself better fitted to withstand the severity of the Arctic circle, and the party of which I speak would in like manner become acclimated, and eventually succeed in accomplishing the long-desired end. With a strong, substantial building, such as could easily be carried on shipboard, the party could be made as comfortable and as safe from atmospheric dangers as are the men of the signal service stationed on the summits of Pike's Peak and Mount Washington, or the employés of the Hudson's Bay Company stationed at Fort York, where a temperature of —60° is not uncommon. A good supply of medicine, a skillful surgeon, and such fresh provision as could be found by hunting parties would enable them to keep off scurvy and to maintain as good a sanitary condition as the

inhabitants of Godhaven, in Greenland. Game was found in fair quantities by the Polaris party on the Greenland coast, and by those from the Alert and Discovery on the mainland to the west, especially in the vicinity of the last-named vessel, where fifty-four musk-oxen were killed during the season, with quantities of other and smaller game. A seam of good coal was also found by the Discovery's party, which would render the question of fuel a light one, and thus remove one of the greatest difficulties hitherto found by Arctic voyagers.

The principal depot or post should be located upon Lady Franklin Bay, between latitude 81° and 82°, and there is no question that this can be reached with a steam vessel, as Captain Hall went as high as Cape Union, between latitude 82° and 83°, with the Polaris, and Captain Nares still higher with the Alert. It is probable that the last-named point may be reached with the vessel, in which case coal and provisions could be deposited there to form a secondary base of operations for the exploring party. If this latter can be done, the road to the Pole will be shortened by about ninety miles in distance and three weeks or more in time, two very important items. It should be clearly understood that the only use to be made of the vessel, which it is hoped will be obtained from the Navy Department, is in the transportation of the men and supplies to the location of the colony. When this is done the vessel will return to the United States and await further instructions. An annual visit might be made to the colony, to carry fresh food and supplies, to keep its members informed of events occurring in the outside world, and bear them news and letters from anxious relatives; to bring back news of progress made and of a private character to friends; also, if necessary, to bring back invalided members of the expedition, and carry out fresh colonists to take their places. The permanent colony should consist of fifty chosen men, mustered into the service of the United States, three commissioned officers, and two surgeons; all to be selected with a view to their especial fitness for work, the young, able-bodied, resolute men, who can be depended upon to carry out instructions to the extreme limit of human endurance. An astronomer and two or more naturalists, to be selected by the National Academy of Sciences, and to work under instructions from that body, but subject to such general supervision and direction from the head of the expedition as is customary at all posts in charge of an officer of the United States, should accompany the expedition. One or more mem-

bers of the regular force should be competent to make meteorological observations, and to communicate by telegraph and signals whenever such communication becomes necessary.

To the expeditionary corps brought from the United States should be added a number of Esquimaux to serve as hunters, guides, etc., and who can be taken over with their families from Disco or Upernavik, in Greenland, and also an ample number of the Esquimaux dogs, so indispensable for sledging and so useful as food when their capacity for work is gone.

The outfit of the expedition should include some two hundred miles or more of copper wire, to connect the colony at Lady Franklin Bay with the subsidiary depot at Cape Union, and thence northward as far as practicable. Copper wire is strong, light, flexible, and a good conductor, and can be worked while lying upon the dry snow or ice without support. The necessary battery, material, and instruments should be taken to equip the amount of line, and the battery could be kept permanently at the Bay station, where, fuel being abundant, it could be kept from freezing. A few sets of signal equipments, such as are used in the army signal service, would also form an indispensable part of the outfit, and all of the men should be instructed in their use and in the signal code. Thus provided with means of communication the sledging parties could move forward with confidence, as they would be able, when necessary, to call upon their comrades who remained behind for advice or assistance. Instead of discouraging further effort, the failure of Nares's expedition from the causes named should stimulate fresh endeavors, and hold out a fair prospect of success. At any rate, the little colony on Lady Franklin Bay, during their three years' residence, besides having the opportunity of selecting an open season and becoming thoroughly hardened and acclimated, would have their work narrowed down to a common focus, — the pathway due north. The work of the Nares expedition clears the way for a direct movement upon the Pole. The explorations westward along the coast by Lieutnant Aldrich, and eastward by Lieutenant Beaumont, obviate the necessity for similar work now. Upon landing and unloading, the stores and provisions quarters should be erected, and the vessel, returning to the United States, would leave behind her a thoroughly equipped, self-supporting, and self-reliant colony which would push, ever northward, the limits of discovery.

The attempt to draw the loaded sledges by means of mere manual labor should not be made unless it should become in any

particular instance a matter of absolute necessity, as it is sure to result disastrously, and seems to have been one of the causes of failure of the Nares expedition. The expedition from the colony to the Pole may consist of eight sledges, with six men to each sledge, the distance to be traveled being some four hundred miles, divided into eight stages of fifty miles each. At the end of the first stage one sledge could be sent back. A portion of the provisions which it originally carried would have been consumed, and the rest would have been deposited in a *cache* in the ice secure from Arctic animals. At the end of the second stage the second sledge would be sent back; at the close of the third stage the third sledge would take up its homeward journey, and following out this plan only a single sledge would remain. The returning sledges being but lightly freighted, and traveling, moreover, a route already pioneered, several of their hands could be retained so as to man the eighth sledge with ten or more explorers. This last sledge with its full complement would perform the most important work of all. It would press forward, reach the Pole, make the necessary observations, and then return. Upon its homeward journey it would follow the route already made in the forward journey, and would find provisions at each successive cache.

During the summer there are probably long lanes of water free of ice from the upper end of Smith's Sound, and following these, against the downward-flowing current, a pathway will surely be found, practicable for boats, during some favoring season. Such favoring season and such a practicable pathway can be found only by men colonized as proposed at a point where — half the journey already safely completed — they will be ready, healthy, vigorous, acclimated, and unwearied by a long and perilous voyage; they will be ready and eager to seize the proffered opportunity. Failing such an opportunity, a chance barely possible, the alternating of sledge journeys still remains, and sledge journeys undertaken under better and more favorable auspices than any which have been as yet attempted.

The severity of the climate on Lady Franklin Bay and in the neighboring regions has been much exaggerated. To parties under cover it is not more trying than that at the summits of Mount Washington, in New Hampshire, or of Pike's Peak, in Colorado, as stated by a former member of one of Dr. Hayes's expeditions, who has since served a year upon the summit of the last-named mountain. The report on the Polaris expedition

shows that during the summer all the lowlands and elevations at Thank God Harbor (opposite Discovery Harbor on Lady Franklin Bay) were bare of snow and ice, excepting patches here and there in the shade of the rocks. The soil at that period was covered with a vegetation of moss interspersed with small plants and willows. The country abounds with life: seals, game, ducks, musk oxen, rabbits, wolves, foxes, bears, partridges, etc. Two seals were shot in the open water.

Again, there are several towns in Northern Asia inside the Arctic circle, and a flourishing city of Russia (Archangel) is not far from it. At Yakutsk, on the river Lena, the ground is frozen solid all the year round, and only thaws a few inches in depth during the hottest summer. Yet this is a town possessing a population of four thousand hardy, prosperous, and contented human beings.

Nostalgia, that dreaded foe of isolated men, found in the members of former exploring parties an easy prey through the long, sunless, Arctic night, and drove some to mutiny and others to suicide, while when the hour of deadly peril came — the supreme moment of despair — the stoutest heart was appalled by the knowledge that succor, if sent at all, must be guided by the merest chance, and that the rude cairn which covered his last resting-place or his frozen effigy upon some drifting ice floe might never meet the gaze of human eye. The new enterprise will go forth under far different auspices to seek a definite rendezvous from which every forward step will be duly chronicled, and the members of the expedition, well knowing that communication will be kept up for their aid, comfort, and supply, will strive with a keener endeavor for the long-coveted prize. Speaking of his expedition in 1861, Dr. Hayes says that the crew were always, and had been, in perfect health; that he was his own ship's doctor, and a doctor without a patient, and that, "believing in Democritus rather than Heraclitus, they had laughed the scurvy and all other sources of ill health to shame." Nor is the danger of Arctic exploration so great as it at first thought appears to be. A distinguished naval officer who has served in those regions states that "of all the seas visited by men-of-war the Arctic have proved the most healthy;" and Mr. Posthumus states, further, that since 1841 England and America have sent out thirty-two expeditions, the total number of deaths from which has been only thirty-eight men, or 1.7 per cent., a percentage which would appear much more favorable if the expeditions of the Germans, Swedes, and Norwegians were included.

To sum up, then, in brief: It is proposed to ascend a well-known and practicable channel to an equally well-known point where exploring parties have previously wintered, and there form a colony. From the post so formed no time will be spent in needless quests along the shore either east or west, as surveys there have already been completed; but starting afresh, the point of our beginning being the closing point of former expeditions, with all the information of our forerunners to commence with, better provisioned, equipped, and disciplined, with better means of intercommunication, thoroughly acclimated, and without the refuge of the ship to paralyze energy and sow the seeds of discontent and slothfulness. In other words: to use alike the partial successes and the partial failures of others, added to the utmost foresight, experience, and scientific aids to form the fulcrum of the Archimedean lever which shall move the Arctic world.

RECENT LITERATURE.

WALLACE'S GEOGRAPHICAL DISTRIBUTION OF ANIMALS.[1] — Although a complete work on this subject by a single writer — and the one under consideration applies, as the author intended it should, almost exclusively to land animals of a comparatively few orders — would in the present state of our knowledge be an impossibility, we know of no one, next to Mr. Darwin, who is better fitted for the task, by training both in the field and in the study, than Mr. Wallace. The work is comprehensive in scope and apparently accurate in details, while the subject is presented in the attractive, clear style of the distinguished author of the Malay Archipelago and the Contributions to the Theory of Natural Selection. It is written, as it should mainly be, in the light of the recent uniformitarian views in geology and the theory of evolution, though with occasional disregard of zoögeographical laws laid down by Humboldt, Brown, Schouw, Schmarda, Decandolle. Agassiz, Dana, and others whose names are not even mentioned in the work before us, no historical sketch of the subject being presented, an omission of considerable importance.

The work is divided into four parts: I. The Principles and General Phenomena of Distribution. II. On the Distribution of Extinct Animals. III. Zoölogical Geography; a Review of the Chief Forms of Life in the Several Regions and Sub-Regions, with the Indications they afford

[1] *The Geographical Distribution of Animals. With a Study of the Relations of Living and Extinct Faunas as elucidating the Past Changes of the Earth's Surface.* By ALFRED RUSSEL WALLACE. In two vols. With Maps and Illustrations. New York: Harper & Brothers. 1876. 8vo, pp. 503, 607. $10.00.

of Geographical Mutations. IV. Geographical Zoölogy; a Systematic Sketch of the Chief Families of Land Animals in their Geographical Relations.

The grand merit of the work, and one which will give a substantial foundation to the author's fame as a biologist, aside from his authorship, simultaneous with Darwin, of the doctrine of natural selection, is the endeavor to account, from a more extended range of study than any previous author, for the present diversity of life on the different continents, by a study of the fossil forms and of past geological changes. He discards the older notions of certain authors, as Humboldt, Schouw, and others, that the distribution of life over the globe is due primarily to differences in temperature and to physical barriers. In how broad a way our author has treated this subject may be seen by the chapter entitled Summary of the Past Changes and General Relations of the Several Regions, reprinted in the last number of this journal. As long ago as 1847 Agassiz stated in his Introduction to the Study of Natural History that "modification of types [on different continents was] not caused by climate," though he proposed no scientific explanation as to how they did originate. Mr. Wallace supposes that all land animals originated in the northern portion of the Europe-Asiatic continent, and thence migrated south into India, Australasia, Africa, and to North America by means of a supposed former polar continent of which Arctic America, Greenland, Iceland, Spitzbergen, and Nova Zembla are the remnants. South America, he suggests, was peopled from North America. This view we suppose to be original with the author, and the hypothesis seems to be supported by known palæontological facts, and may serve as a working theory until a better one is offered. Mr. Wallace's view that the primitive centre of distribution was in the Old World is based on the fact that life is more abundant and the continental mass larger than that of North America. Mr. Wallace quite thoroughly disposes of the notion, advanced by Heer, Murray, and others, of continental bridges, and fully recognizes the facts strenuously maintained for years by Dana and others, and proven by the late deep sea explorations, that the present ocean beds have always been such,[1] oscillations of the original continental masses and the evident former existence of an arctic Americo-European continent being sufficient to account for the regular and normal interchange of life, which palæontology shows must actually have occurred.

The limits of the six primary regions into which the earth's surface is divided by our author have been marked out by geological agencies

[1] "The preliminary studies above enumerated will, it is believed, enable us to see the bearing of many facts in the distribution of animals, that would otherwise be insoluble problems, and, what is hardly less valuable, will teach us to estimate the comparative importance of the various groups of animals, and to avoid the common error of cutting the gordian knot of each difficulty by vast hypothetical changes in existing continents and oceans, probably the most permanent features of our globe." (Vol. i., p. 9.)

almost wholly. When, however, we come to the zoölogical subregions, temperature and mountain barriers, rivers and deserts are factors for the most part, though not always duly recognized in this work, for climatic causes are, we think, not given sufficient prominence, and the correspondence between zones of temperatures, and the distribution of faunæ are too lightly discussed. For example, he rejects the idea of an arctic region with a circumpolar fauna, contrary to the well-founded views of Agassiz, Dana, Huxley, and others, though he gives some good reason for his own opinion. Mr. Wallace's six regions are those originally proposed by Sclater, namely, the Palæarctic, Ethiopian, Indian, Australian, Neotropical, and Nearctic.

Mr. Wallace disbelieves in the existence of an antarctic region, and we should be inclined to agree with him, but we see no good reason, if we are to confine ourselves to existing facts of distribution, for ignoring a seventh arctic region embracing all of America, Europe, and Asia north of the isothermal of 32°. We should follow Agassiz (1847) and others, as well as Huxley (1868) and put the northern limits of the Palæarctic and Nearctic regions, or Europe, Asia, and North America, respectively, south of the isothermal of 32°. In this case, we think, Mr. Wallace treats too lightly the importance of temperature in limiting zoögeographical regions, and is disposed to rely too strongly on the fact that this arctic region had in former times a warm climate, and supported a flora and fauna like that of north temperate Europe, Asia, and America. But the Glacial epoch destroyed the continuity of climate, and at the present time temperature is the prime factor in limiting life as regards this region of the globe. When we turn to the distribution of marine invertebrate life, a subject almost wholly ignored by Mr. Wallace, the extension into the arctic zone of Mr. Sclater's Nearctic and Palæarctic regions is entirely arbitrary. All the facts brought out by deep-sea researches and Scandinavian, British, and American marine zoölogists tend to prove most forcibly that there is a circumpolar fauna, no more European-Asiatic than American,[1] and that this fauna may, at great depths, where the temperature of the water is the same (as it actually is), extend to Cuba and underlie the tropical zone of life. In fact, the fauna of the sea is primarily polar or frigid, and tropical, and we believe that Messrs. Sclater and Wallace are quite wrong in ignoring the fact that even land animals share largely in this distribution. Indeed, in discussing the distribution of marine life, temperature is the main element in the limitation of zoölogical regions and subregions, as first shown by Professor J. D. Dana in 1853, in his essay on the geographical distribution of Crustacea, and again and again proved by marine zoölogists and the results of the explorations by the United States Coast Survey, by Scan-

[1] Since the publication of Mr. Wallace's work, in the Reports of the Valorous Expedition to Greenland, Mr. Jeffreys argues against and Mr. Norman in favor of the Greenland marine fauna being American rather than European.

(FIG. 28.) A SCENE IN CUBA, WITH CHARACTERISTIC ANIMALS.

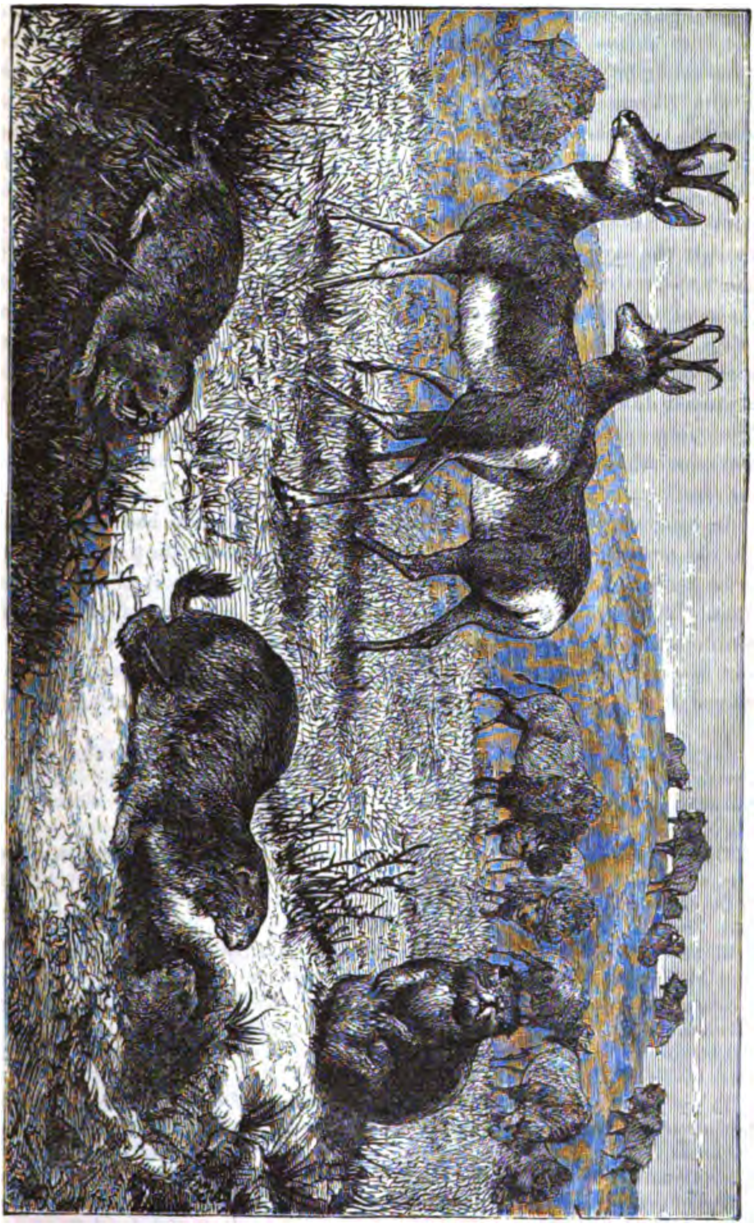
dinavian, and the Porcupine and Challenger, and other English expeditions. We are disposed to find some fault with the present work in not considering the subject from a stand-point so important as this.

To return to the theory as to the origin of the present distribution of life on the great continents by means of a migration from lands to the north. While the idea is evidently original with Mr. Wallace, he seems to have overlooked some suggestions made by writers in the United States previous to the publication of his work. More than twenty years ago Professor Asa Gray[1] proposed the hypothesis that the present vegetation of North America "or its proximate ancestry must have occupied the arctic and subarctic regions in Pliocene times, and that it had been gradually pushed southward as the temperature lowered and the glaciation advanced even beyond its present habitation." He also attempted to show that certain forms might survive in Japan and the Atlantic United States, "but not in intermediate regions of different distribution of heat and moisture." . . . . And it was thought that the occurrence of peculiarly North American genera in Europe in the Tertiary period (such as *Taxodium*, *Carya*, *Liquidamber*, *Sassafras*, *Negundo*, etc.) might be best explained on the assumption of early interchange and diffusion through North Asia rather than by that of the fabled Atlantis." These views were confirmed by Lesquereux. In 1873 the reviewer applied this hypothesis to the origin of the distribution of animals, particularly insects.[2] We then, in discussing the origin of our North American fauna, drew the inference that "cospecific or congeneric forms occurring in California and Europe and Asia are the remnants of a southward migration from polar Tertiary lands during Tertiary and even perhaps Cretaceous times, and in proportion to the high antiquity of the migrations there have been changes and extinctions causing the present anomalies in the distribution of organized beings, which are now so difficult to account for on any other hypothesis."

As Mr. Wallace could not in such a work enter into details of distribution beyond briefly describing his subregions, in which temperature and natural barriers need to be studied with care, he may have been led into the error of underestimating the influence of zones or temperature in determining the limits of distribution within the subregions. Much excellent work that has been done in this direction by American naturalists, who have had much better opportunities than European students, has been too hastily discussed either from want of space or from lack of information, since the great extent of North America as compared with that of Europe is exceedingly favorable to the formation of correct opinions regarding the influence of climate on species, an influence of greater

[1] Memoirs of the American Academy of Arts and Sciences. Boston. Vol. 6. See Sequoia and its History, American Naturalist, October, 1872, pp. 589, 590.

[2] On the Distribution of Californian Moths. By A. S. Packard, Jr. American Naturalist, August, 1873, and Proceedings of the Boston Society for May, 1873.



(Fig. 29.) THE NORTH AMERICAN PLAINS, WITH CHARACTERISTIC MAMMALIA.

importance in the origin of species than Darwinians as such seem willing to admit.

The errors of detail in the chapters we have read seem very few, and the wonder is that there should not be more. We notice that *Phrynosomæ*, or horned toads, are stated on one page to exist in New York and on another in Florida. We are not aware that the genus occurs east of the Mississippi River. *Siredon* is referred to the family *Proteidæ*, when it has been shown by Dumeril and Marsh to be simply a larval *Amblystoma*. An attractive feature of the work are the twenty full-page illustrations, showing the chief forms of land vertebrates characterizing the subregions. They are drawn with skill and evident fidelity, though the skunk on Plate XX. is not well sketched. Through the courtesy of the American publishers our readers can judge of the excellence of the plates by a glance at the two accompanying illustrations (Figs. 28 and 29). The colored hypsometrical maps add greatly to the value of the work. In that of North America the author colors yellow supposed desert tracts east of the Rocky Mountains, which farmers in Wyoming and Colorado would consider as reflecting on their possessions, and over which herds of buffalo a few years ago must have grazed with satisfaction.

In conclusion it may be said that while our author has shown that life has probably originated in northern lands, the question still remains to be answered, and the problem will probably not be solved for generations. What caused the radical differences in the life of the several continents? The united efforts of future palæontologists and biologists will be concentrated on this task, and centuries hence, if we mistake not, Alfred R. Wallace will be regarded as the pioneer in the work.

RECENT BOOKS AND PAMPHLETS. — The Naturalist's Guide in collecting and preserving Objects of Natural History, with a Complete Catalogue of the Birds of Eastern Massachusetts. By C. J. Maynard. With Illustrations by E. L. Weeks. Salem: The Naturalists' Agency. 1877. 12mo, pp. 170. $2.00.

The Naturalist's Directory, containing the Names of Naturalists, Chemists, Physicists, and Meteorologists, arranged alphabetically, with an Index arranged according to Departments. By Samuel E. Cassino. Salem, Mass: The Naturalists' Agency. 1877. 8vo, pp. 20. Interleaved.

Materials towards a Knowledge of the Postembryonal Development of Insects. By Prof. M. Ganin. Warsaw. 1876. 4to, with plates.

Biologische Studien. Von Prof. Ernst Haeckel. Zweites Heft: Studien zur Gastræa-Theorie. Mit 14 tafeln. Jena. 1877. 8vo, pp. 99.

Beitrage zur Naturgeschichte der Daphnoiden. Von Prof. August Weismann. Parts II.-IV. Leipzig. 1877. 8vo, pp. 161.

On the Structure and Relations of the Alcyonarian *Heliopora cærulea*, with some Account of the Anatomy of a Species of Sarcophyton, Notes on the Structure of Species of the Genera Millepora, Pocillopora, and Stylaster, and Remarks on the Affinities of Certain Palæozoic Corals. By H. N. Mosely. (From the Philosophical Transactions of the Royal Society.) London. 1876. 4to, pp. 38.

Proceedings and Transactions of the Nova Scotian Institute of Natural Science of Halifax, Nova Scotia. IV. part 2. 1875–76. 8vo.

The Valorous Expedition. Reports by Dr. Gwyn Jeffreys and Dr. Carpenter. (From the Proceedings of the Royal Society, Vol. xxv. No. 173.) With chart and Sections. London. 1876. 8vo, pp. 60.

Check List of the Fishes of the Fresh Waters of North America. By David S. Jordan and Herbert E. Copeland. (From the Bulletin of the Buffalo Society of Natural Sciences.) 1877. 8vo, pp. 31.

The Fourth Annual Report of the Board of Directors of the Zoölogical Society of Philadelphia. 1876. 8vo, pp. 38.

Catalogue of the publications of the U. S. Geological and Geographical Survey of the Territories. F. V. Hayden, Geologist-in-Charge. Second Edition. (Revised to December 31, 1876.) Washington, D. C. 1877. 8vo, pp. 38.

Remarks on some Algæ found on the Water Supplies of the City of Boston. By W. G. Farlow. (Extracted from the Bulletin of the Bussey Institution. January, 1877.) 8vo, pp. 80.

Geological Survey of New Jersey. Annual Report of the State Geologist, for the year 1876. Trenton, New Jersey. 1876. 8vo, pp. 56.

New York Aquarium Journal and Guide. Illustrated. New York.

GENERAL NOTES.

BOTANY.[1]

On the Passage of Plasma through Living Unperforated Membranes, by M. Cornu. — The transfer of elaborated matters in cells presents many difficulties; in many cases osmosis alone is an inadequate explanation; it has been thought necessary to assume solution and recomposition of the substance, as in the case of starch. That the transfer of starch takes place in this way has been apparently admitted as the result of Mer's researches. Does plasma pass in the same way through the cell wall, having become first dissolved? Cornu thinks that it is transferred without solution, and bases his conclusion on his study of the germination of the spores of one of the Mucedineæ. In this case the plasma passes directly through the wall without rupturing it. The details of this most interesting observation are given in *Comptes Rendus*, January 15, 1877.

Phellodendron. — The list of exotic trees capable of withstanding the severities of the New England climate is not a long one, and any addition to it is a cause for congratulation, especially when, as in the case of *Phellodendron Amurense*,[2] the new-comer is extremely ornamental, and of rapid growth. Two plants of this *Phellodendron*, raised from seed in the Harvard Botanic Garden many years ago, are now some fifteen feet high, and have flowered the past summer for the first time; and as they have been fully exposed during ten or fifteen years, their hardiness in our climate would seem to be beyond doubt. The flowers of *Phellodendron* are diœcious, but by a piece of remarkable good fortune the two plants bore flowers of the two sexes, and an

[1] Conducted by Prof. G. L. Goodale.

[2] Rupurt and Maxim., Fl. Amus. t. 4.

abundant supply of seed has been secured. *Phellodendron Amurense* is a native of Manchuria, where, according to Maximonicz, it becomes a handsome, thick-leaved tree, fifty feet high, and with a trunk a foot in diameter. It occurs also in Japan, where a second species has been detected.

Phellodendron can be characterized by its corky bark; opposite, unequally pinnate leaves; oblong, lanceolate, acuminate, sharply serrate leaflets; small, green, diœcious flowers, borne at the extremity of the branches in loose corymbs; and by its five seeders, black, odoriferous, pea-shaped drupes, with flattened seeds, which in our species are two lines long, and covered with a shining black *testa*.

Its nearest North American allies are *Ptelea* and *Xanthoxylum*. — C. S. Sargent.

Modification of the Glumes of Grasses depending on the Sex of the Flowers. — Fournier gives as the result of his study of the grasses of Mexico the following statement: Among grasses with separated sexes, the female flowers differ very little, if at all, as regards the situation or form of the floral envelopes, when the sexes are borne on different plants; but when the plant is monœcious the glumes of the two sexes are widely different. These differences are most marked in certain genera of Chlorideæ, normally diœcious and accidentally monœcious. The grass described by Engelmann under the name *Buchlöe dactyloides* is a curious example in point. Beside this is now placed *Opizia stolonifera*, of which Presl had seen only the female plant. Although the female flowers of these plants differ very widely, their male plants resemble each other so much that they have been put in the same genus. *Casiostega humilis* is the male form of *Buchlöe*, and *C. anomala* is the male form of *Opizia*.

Living and Fossil Oaks of Europe compared by De Saporta. — Before the end of the Miocene, Europe possessed oaks which closely resembled *Quercus Cerris*. They had cupules of the same kind as the one now living, and the fruit matured in the second year. Three species in Auvergne belonged to the type of *Quercus Robur*, and "did not differ from the forms of this group more than these forms differ from one another." *Quercus pedunculata, sessiliflora*, and *pubescens* are relatively recent. In the middle of France, at least, these races have been preceded by other oaks, which have since partly disappeared and partly have been confined to a region farther south. On the other hand, species which now occupy only limited stations where they are threatened with extinction, like *Quercus Cerris* in France, appear to have had direct representatives there at an epoch relatively remote.

Absorption of Carbonic Acid by the Vegetable Cell Wall, by Professor Bohm, of Vienna. — Carbonic acid is atmospheric air, absorbed not only by the contents of green cells but by the cell walls themselves. Branches dried at 100° C. absorb more carbonic acid than

fresh twigs. But while in the latter the absorbed gas can be driven off tolerably rapidly by oxygen, hydrogen, or nitrogen, this happens in the first just as in the case of carbon, only more slowly."

BOTANICAL NOTES FROM RECENT PERIODICALS. — *Flora.* Batalin, Mechanism of the Movements in Insect-Eating Plants (not yet finished). Dr. Celakovsky, On the Morphological Structure of *Vincetoxicum* and *Asclepias.* A. Poulsen, The Occurrence of Crystals surrounded by Cellulose (Rosanoff's crystals detected in the leaf stalks of many Leguminosæ).

Botanische Zeitung. 1877, No. 1. Dr. DeVries, On the Extension of Growing Vegetable Cells by Turgescence. V. Waldheim, A Fungus on Rumex. Nos. 2 and 3, Beyerinck, On Galls. No. 4, Jack, On European Hepaticæ. Continued in No. 5. Dingler, On *Lathræa rhodopea.*

ZOÖLOGY.

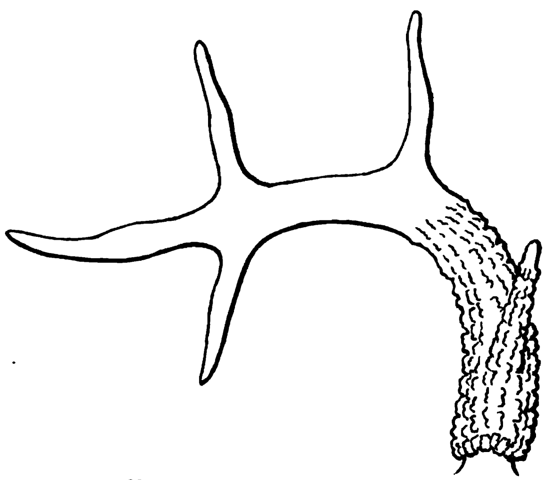
THE COMMON CRAB (CARCINUS MŒNAS) AT THE HAWAIIAN ISLANDS. — I desire to direct attention to the crustacean genus *Carcinus*, of which there is but a single species, *mænas.* In 1873 the writer obtained a specimen from the Hawaiian Islands. This is the first well-authenticated instance, to his knowledge, where the species is recorded as coming from Pacific regions. In the Museum of the Academy of Natural Sciences of Philadelphia there is a specimen labeled from Australia, with an interrogation mark. It is found along the whole coast of Europe, from the Baltic to the Mediterranean; it is equally common and as widely distributed along our Atlantic coast. Heller reports having found the species on the eastern coast of South America, and it has likewise been obtained from the Red Sea; and now the Pacific Islands are added as a habitat. In the latter region, however, it cannot be very common, as it has eluded research up to the time mentioned, notwithstanding the fact that these islands have been pretty thoroughly ransacked for this kind of life. It may, however, be considered as cosmopolitan, as having a wider range than any other known species of crab.

What is particularly interesting in connection with its wide distribution is the identity of the species wherever found. Very slight differences can be observed in the specimens coming from these widely separated localities. The differences are not sufficient to constitute distinct species; at the most they would only form varieties. Carcinologists have agreed, however, to ignore the slight geographical variations and to designate them all by the same name.

The difference consists principally in the extent of the granulations on the surface of the carapace, and in the prominence of the front. Our Atlantic-coast crab differs from the European in having the surface more granular, and the teeth of the front somewhat more prominent; in the Pacific specimen the granulations are larger, and the front more projecting when compared with the former. It will be observed that

the changes increase in intensity as we travel westward. I do not know how these facts would hold through a large series of specimens; I have had an opportunity of comparison only with a limited number of specimens. The wide distribution of the crab, as is the case with all other forms of life similarly diffused, has had a tendency to preserve the species intact and to prevent a wide divergence from the primitive type. Those natural climatic laws which operate with the greatest intensity on those forms which are confined to restricted habitats are in this case inoperative. — THOS. H. STREETS, M. D., U. S. N.

NOTE ON THE DEFORMED ANTLER OF A DEER. — Dr. W. J. Hoffman, of Reading, Pa., sends me the accompanying figure and description of a malformation of the antler of a deer, probably a variety of *Cariacus Virginianus*. The specimen is said to have been obtained in California some years ago, and is now in the possession of a gunsmith in Reading.



(FIG. 80.) DEFORMED ANTLER OF A DEER.

The figure is taken from the right antler, viewed in position to occasion the least foreshortening of the supernumerary tine. It is drawn on a scale of one-tenth. The tips of the extra prongs are about twenty-six inches apart; distance between their bases, twenty-two inches. Although the various malformations of antlers are almost endless, yet each one has its own interest as an item in the history of the subject; and the facility of pictorial illustration of this class of objects renders extended description unnecessary. — ELLIOTT COUES.

THE BLACK SQUIRREL. — A female specimen of this species (*Sciurus niger*) of the exact color of the mink, the tail hairs light ochreish at the ends, was shot at Rodney, C. W., October 20th, by Mr. James Delaney, of Buffalo. The specimen is in the collection of the Buffalo Society of Natural Sciences, and it is remarkable for its extraordinary color, which is precisely that of the mink instead of the usual black of the species. — A. R. GROTE.

THE RAVEN AND THE SOOTY TERN IN WILLIAMSTOWN, MASS. — Some time since I secured here a fine specimen of the American raven (*Corvus carnivorus* Bartram), the first of its species, so far as I know, that has been captured in this region. Also last September I secured here a good specimen of the sooty tern (*Sterna fuliginosa* Gmelin) which, according to Lawrence, has its habitat in the latitude of Florida and Texas. It was killed near the Hoosac River. — SANBORN TENNEY.

PARTIALITY OF WHITE BUTTERFLIES FOR WHITE FLOWERS. — On a September afternoon I observed in a field where a low white aster and a common golden-rod (Solidago) were abundant, twelve European cabbage butterflies (*Pieris rapæ*) fly directly to the less conspicuous but white aster, and invariably pass by the yellow flowers of the golden-rod. On a following day, however, the white cabbage butterflies on the same spot were seen occasionally to visit the golden-rod, but with an evident partiality for the white asters. On the other hand, the yellow sulphur butterfly (*Colias philodice*) visited the flowers of the golden-rod much oftener than those of the aster. — A. S. PACKARD, JR.

THE PHENOMENA OF DIGESTION IN THE COCKROACH. — In a late paper on this subject Prof. Felix Plateau concludes that the food after being swallowed accumulates in the crop, where it is acted upon by the salivary fluid, which is usually alkaline. There the starchy substances are transformed into glucose; this first product of digestion is here absorbed, and is not met with in the rest of the digestive canal. The valvular apparatus, which does not play the rôle of a triturating organ, allows small quantities of the matter in process of digestion to pass into the middle intestine of limited capacity.

This median intestine, or stomach, as it is usually called, receives the sugar secreted by light glandular cæca, the sugar being ordinarily alkaline, never acid, neutralizing the acidity as the contents of the crop gradually increase, transforming the albuminoids into bodies soluble and assimilable, analogous to peptones, and emulsionizing the fatty portions.

Finally, in the terminal part of the intestine are reunited the residues of the work of digestion, and the secretions of the Malpighian tubes, which are purely urinary in their nature. These researches complete and confirm throughout the results of Plateau's former investigations on the digestion of insects, published in 1874.

THE PAPER ARGONAUT CAPTURED AT LONG BRANCH, N. J. — Some little while ago a fisherman caught a strange object, and brought it on shore. It was the paper nautilus, the first time, probably, this animal has ever come so far north. Dr. Chattle made proposals to have it sent to Dr. Lockwood, which elicited a promise to that effect. But an enterprising genius got hold of the fisherman, and the nondescript was put in a tub of water and shown up at twenty-five cents a head. The animal was at last thrown away. — *Monmouth Democrat.*

The above occurred in August last, while I was out of the State. On

my return, to my great grief, I learned that the specimen had been wantonly lost. My informant in the matter is Dr. T. G. Chattle, of Long Branch, a gentleman of generous culture, and good observing ability. From his description I am satisfied it was an *Argonauta*, and very likely, though we may not be positive, the species was *A. gondola*. The animal was kept alive eight or nine days. Sometimes it displayed its arms in a feeble attempt to swim in its narrow confinement. Is not this the first instance of a capture so far north? Query, did this ancient mariner of the poets take it into its head to get into the Gulf Stream, and make us from its old-time seclusion, as some other folks have done, a centennial visit? — S. Lockwood.

A Flight of Butterflies. — About the first of October, while seated with a friend on the top of "Pegan Hill," an elevation of some four hundred feet, our attention was attracted to a continuous line of passing butterflies flying in a direct course towards the south, and at the height of thirty or forty feet above our heads. The day was warm and summer-like, with no wind to disturb the flight of the butterflies, which was remarkably steady and even, like the flight of migrating birds, and very unlike the usual zigzag movement of butterflies. We watched them for nearly an hour as they appeared in view from the north and moved steadily onward towards the south. Sometimes they appeared singly, sometimes in groups of three or four, but oftener in pairs, and flying six or eight feet apart. Being anxious to obtain a specimen, that the species might be determined, we made several vain attempts to bring one down by sending our walking-sticks after them. This put them in great confusion, entirely breaking up their line of march, and causing them to dodge rapidly to the right and left, and frequently to drop down several feet; although they continued on at the same rate of speed, they seemed unable to regain their former even flight, but kept up this zigzag motion till lost sight of in the distance. They were apparently one of our largest species, and were visible at least one eighth of a mile as they appeared in sight; it seems an important fact that they did not change their altitude in passing over the hill. We also noticed when descending the hill towards the north that they were flying at the same level till we were so far below them that they appeared but mere specks in the air above our heads, and before we had reached the plains below we had entirely lost sight of them. There was no reason to suppose that the butterflies changed their course in order to pass over this hill, or that the flight did not extend over the surrounding country. Having never seen any notice of the migration of butterflies or their movement *en masse*, it occurred to me that the phenomenon might happen annually, but at such a height as to pass unobserved. The butterflies were of large size and of a dark-brown color, but too distant to enable us to determine their markings. — Wm. Edwards, South Natick, Mass.

The preceding sketch, received from a correspondent, describes one

more instance of the rarely observed migrations of butterflies, and is printed in the hope of drawing forth accounts of similar observations. It is of course impossible to identify the butterfly seen by Mr. Edwards, but the swarming habits and lofty, sailing flight of *Danaida Plexippus* very naturally suggest this common insect. There are only two other common dark-colored butterflies which would be suspected of moving in such migratory swarms, *Vanessa cardui* and *Eugonia j-album*, and their flight would be different from that described by Mr. Edwards. Instances of the pseudo-migration of *Vanessa cardui* have been recorded in Europe,[1] and of a species of Eugonia (*E. Californica*) closely allied to *E. j-album*, in America (by Dr. Behr; Proc. Calif. Acad. Sciences, iii. 124). It has been suggested that these occasional movements among butterflies, which have been observed, especially in the tropics, in several genera of the larger forms, might be explained by a scarcity of the food-plant of the caterpillar, upon which the female lays its eggs; but this would scarcely be applicable to *Vanessa cardui*, since thistles and mallows — the food-plant of the larva — are abundant and wide-spread weeds. It would be well in observing such moving swarms to collect as large a number of butterflies as possible and determine the sex of each individual and the comparative maturity of the eggs.

It may be added, that when these observations of Mr. Edwards were read before a meeting of the Natural History Society of Boston, Mr. B. P. Mann stated that he once observed in Brazil a similar flight of a species of *Coea* or an allied genus. — SAMUEL H. SCUDDER.

ANTHROPOLOGY.

ANTHROPOLOGICAL NEWS. — The most thorough and successful archæological work done on American soil in the last two years is that of Mr. Paul Schumacher in the Kjökkenmöddings and graves of the extinct races of the Santa Barbara Islands and the mainland. The islands examined were San Miguel, Santa Cruz, San Nicolas, Santa Barbara, and Santa Catalina. The mainland examined was the coast region of Santa Barbara and San Luis Obispo counties, most especially that portion in the vicinity of Point Sal. The Kjökkenmöddings are found wherever sandy ground exists. The deposits in these heaps are so much exposed to the driving winds that many of the objects of interest have been laid bare and carried off by casual visitors. The same winds which denude the shell heaps also expose the large whale's bones which were used by the former inhabitants to separate the bodies in the well-filled graves, and in this way serve as veritable tombstones to mark their sites. Mr. Schumacher opened several of these ancient sepulchres and took therefrom over a thousand skeletons, and with them many articles of ornament or use. The bodies were buried from three to six feet under ground, and sometimes from three to five deep; but it is evident from

[1] See American Naturalist, x. 610.

the disturbed condition of many skeletons that the burials were not all made at the same time. Most of these cemeteries are in the Kjökkenmöddings themselves, because the soil of these heaps is the only place which is not too hard for the aboriginal wooden spade, and is yet sufficiently firm to allow the digging of a pit. In connection with these digging sticks, Mr. Schumacher makes a very ingenious observation concerning the great quantities of stone rings, or "doughnuts," which are found here. From the testimony of an old vaquero he was led to believe them to have been designed to give weight to the spading stick. Among the many interesting objects of industry found, the mortars and pestles hold the first place. The fishing tackle comes next. Mr. Schumacher was so fortunate as to secure a full set of shell fish-hooks, and tools for making them, so as to illustrate the whole process. The shell ornaments and other burial deposits form a collection which must be seen in order to be appreciated.

Mr. Moses Strong, Assistant State Geologist of Wisconsin, has made a very extensive survey of the prehistoric mounds of Grant County in that State. These mounds are similar in all respects to those reported by Mr. I. A. Lapham in the seventh volume of the Smithsonian Contributions.

Quite a lively discussion has sprung up in the *Academy* for September 23d, et seq., around the assertion of Professor Mahaffy that cats were domestic animals among the Greeks, basing his belief upon the occurrence of the word γαλῆ in Aristophanes and other Greek writers. The question of the existence of domestic cats in Greece is discussed by Sir G. Cornwall Lewis (Notes and Queries, 1859, page 261). The subject is also treated by Professor Rolleston in a paper entitled, On the Domestic Cats, *Felis domesticus* and *Mustela Foina*, of Ancient and Modern Times, in the *Journal of Anatomy and Physiology*, November, 1867. The γαλέη, or γαλῆ, then, was one of the *Mustelidæ*, or martens, and the domestic cat was not known outside of Egypt before the Christian era. Mr. Mahaffy gracefully acknowledges the correction.

In the *Geographical Magazine* for October, Mr. E. G. Ravenstein publishes a series of maps of the part of Eastern Europe occupied by the Turks, showing (1) Political Divisions; (2) Density of the Population; (3) Mohammedans; (4) Nationalities. The author also reviews the history of that part of Europe overrun by the Turks.

Mr. A. H. Sayce reviews very favorably, with some slight criticisms, in *Academy* for October 14th, four very important works on Oriental Archæology: An Archaic Dictionary, W. R. Cooper (London: Baysted and Sons, 1876); Cory's Ancient Fragments. New and enlarged edition, E. R. Hodges (London: Reeves and Turner, 1876); Dates and Data relating to Religious Anthropology and Biblical Archæology (London: Trübner & Co., 1876); and Histoire ancienne des Peuples de l'Orient, 2nde Edition. Par G. Maspero (Paris: Hachette et Cie., 1876). The

first of these works is an attempt to do for Egypt and Assyria what Lemprière has done for Greece and Rome. The second work mentioned is an improved reprint of Cory's magnificent design of bringing together all the scraps of classical literature that bear upon the history and antiquity of the ancient East.

In the third work, the anonymous author "arranges in consecutive order, under specific dates, some of the results of recent researches on prehistorical and Biblical archæology and comparative mythology, with the view of attempting to furnish trustworthy materials for the study of religious anthropology." Of the last-mentioned work Mr. Sayce says, "The work is simply indispensable for all who wish to have some acquaintance with the subject."

In the *Contemporary Review* of April, Mr. Sayce discusses the jelly-fish theory of language. The principal feature in this theory is the belief that the sentence is the fundamental unit, and that words, especially "abstract and general terms, are only short-hand notes, in which we sum up the results of our analytical processes." — O. T. Mason.

GEOLOGY AND PALÆONTOLOGY.

The Trenton Limestone at Minneapolis. — The Trenton limestone in the vicinity of Minneapolis presents many features of interest both to the student of science and the simply commercial observer. The value which it possesses as the support of our magnificent water-power is sufficiently well known and appreciated. But to the student it is of interest on account of its accessibility and the varied forms of life which are preserved in it. Below are given a few notes upon some of the many fossils which have been broken from the massive escarpments that overlook the Mississippi below the fall. Two important divisions may be seen in the rock which are nearly equal in thickness. The upper being crystalline, the lower more firm, and better adapted for building purposes. Both are surmounted by a thin layer of shale of varying thickness. The total height of these in a vertical section is forty feet in round numbers, but it lies an equal distance above the river-bed, being supported by the St. Peter sandstone.

It is interesting to notice that the lower or building rock is not as devoid of fossils as has been somewhat generally supposed. There seems to be good reason to believe that life was at least as abundant at the period when these rocks were deposited as in the succeeding one. The reason the fossils in the lower rock have been overlooked is obvious on a careful study of the rocks. The upper is quite crystalline and the fossils preserved are almost entirely in the form of casts; these are loose and easily broken from the rock; they are also generally colored by iron, which is seldom the case in the lower layers.

Though it is true that they have been to a great extent destroyed, yet by a careful manipulation of the building rock many curious forms are

brought to light and they will be found much more perfect than those of the crystalline rock. In one locality *Cyrtolites compressus* (Con.) seems almost to form the basis of the stone. So abundant is it that a fragment could not be broken out without bringing to light some portion of a shell. *Chætetes lycoperdon* H. is also abundant, universally appearing on weathered surfaces in connection with *Escharopora recta* H., *Stictopora acuta* H., and other corals of a like nature, and crinoidal stems. *Chætetes* is detected in the body of the rock only by the diverging canals seen in a longitudinal section. The curious glabellæ of *Isotelus Iowensis*, or a related trilobite, is often seen in connection with fragmentary remains of other crustaceans. The textile markings of *Strophomena filotexta* H. and the rays upon the shell of *S. alternata* H. are well preserved, while in the upper layers only casts of a very imperfect kind were seen. Many other brachiopods are quite abundant, as *Rhynconella capax* Con., *Orthis testudinaria* Dal., *Strophomena deltoidea* H., etc. *Orthis subquadrata* H., is not uncommon, I think, in both layers. Lingulæ have been found throughout the series, *Lingula quadrata* and forms which may prove to be juvenal and distorted specimens of the same. Among gasteropods the Trenton limestone here is found to contain *Pleurotomaria lenticularis* H., *P. subconica* H., *P. subtilistriata* H., common to both divisions. With regard to the last, a specimen of this species which Professor Hall mentions as having been found only in the concretionary beds of Trenton at Watertown, N. Y., was found in the upper layers at Minneapolis, the size corresponding with that of the largest seen by Professor Hall. *Pleurotomaria umbilicata* H. is exceedingly abundant in the upper rock and a supposed cast of *Murchisonia gracilis* was broken from the same horizon as *Cyrtolites compressus*.

The shale on weathering leaves well-preserved shells and corals which appear almost as perfect as though collected from their native waters, particularly *Chætetes*, *Rhynconella*, and sections of crinoid stems in great variety.

Lamellibranchs are not wanting in all portions, the following having been noticed: *Edmondia subangulata* H. (one specimen). *E. subtruncata* H. (very abundant but quite variable in form. Casts alone have been found.) *Nucula levata* H., as well as several as yet not determined. — C. L. Herrick.

Whiteaves' Mesozoic Fossils of British Columbia. — The fossils described and figured in this report of Mr. J. F. Whiteaves, palæontologist to the Geological Survey of Canada, are mostly cephalopods, particularly *Ammonites* from the coal-bearing rocks of the Queen Charlotte Islands. The author states that "what little direct and positive evidence is at present afforded by the fossils from the Queen Charlotte Islands is in favor of their being referred to the Cretaceous period." Again he says more explicitly on page 91, "While, on the one hand, the fossils described in these pages show that the probable geological posi-

tion of the beds which contained them is near the base of the lower Cretaceous formation, or top of the upper Jurassic, they are insufficient to mark the definite horizon to which the series should be referred. It is sufficiently obvious that they exhibit a blending of the life of the Cretaceous period with that of the Jurassic."

ROMINGER'S FOSSIL CORALS OF MICHIGAN. — This is a treatise on the indigenous fossil corals of Michigan, forming the palæontology of the Reports on the Geology of the Lower Peninsula of Michigan. The value of the work is greatly enhanced by the large number of excellent photographic figures, printed by the Albertotype process. There are fifty-five plates, each usually containing four figures. A good many new species are described, and the work bears evidence of care in its preparation.

GEOGRAPHY AND EXPLORATION.

GEOGRAPHICAL PROGRESS IN 1876.[1] — The geographical feature of the past year has been the increased interest shown in the enlargement of geographical knowledge, not only by the investigations and explorations which have taken place and the discoveries which have been made, but by the establishment of geographical societies in Denmark, Spain, and Portugal, by a large increase of members in the leading societies of England, France, and Italy, and in the inauguration by the king of Belgium of an international organization, composed of prominent geographers, African explorers, and the heads of the leading geographical societies of the world, to carry on the work of exploring and civilizing the interior of Africa upon a systematic plan, — a movement of great interest, and which in all probability will lead to very important results. The Challenger returned May 24, 1876, after an absence of nearly four years.

Archæological researches have during the past year been active and attended with interesting results. E. T. Wood, who spent eleven years in exploring the site of the City of Ephesus, contending with marauding brigands, and working in pits and trenches almost constantly under water, has during the year published the account of his labors. The German archæologists, Drs. Hirschfeld and Weil, and Mr. Bötticher, have been engaged during the year in making excavations at Olympia, in Greece, which, beside clearing the ruins of the temple and laying bare its marble pavement, have led to the discovery of numerous inscriptions, sculptures, and other objects of interest. The site of the celebrated temple, which for centuries was a dreary waste, has now, in consequence of these discoveries, become a resort for tourists. Mr. L. P. di Cesnola, who has been absent for three years continuing his researches in Cyprus, ended his labors last autumn, and is now upon his return to this city. He has discovered the site of Kurium, mentioned by Strabo, of which

[1] Abstract of Judge Daly's Address at the Annual Meeting of the American Geographical Society, New York, January 23, 1877.

no trace existed, identified the great temple of Apollo, and discovered the treasure chambers of another unknown temple, filled with innumerable votive offerings. He says that his last three years' excavations have surpassed those of the seven preceding years. Dr. Schliemann has followed up his excavations upon what he supposed to be the site of ancient Troy, by excavations upon the site of Mykenæ. Mykenæ is the most ancient city in Greece. It is identified with the poems of Homer, and Dr. Schliemann supposes that he has found the tombs of Agamemnon, Clytemnestra, and other Homeric personages. But whether he has or not, he has found and opened tombs which, from their cyclopean structure, belong to a very early period of Greek civilization. His excavations, which have been extensive, disclose the general topography of this very ancient and wealthy city, the monumental and other remains of which he carries back to 1200 B. C., the period to which the Homeric poems are usually ascribed.

In the United States the Coast Survey has made careful soundings in the Gulf of Mexico; the Hydrographic Bureau has assisted in correcting the charts of the West India Islands; the survey of the lakes has been carried on by the United States Engineer Corps; Colonel Ludlow's report of his reconnaissance from Carrol in Montana to the Yellowstone National Park has been published; the explorations of Lieutenant Wheeler west of the one hundredth meridian have been continued; Lieutenant Bergland has completed the examination of the Colorado River; Professor Hayden's explorations and other work have been carried on; Major Powell's expedition organized six field parties which surveyed much of Utah and Nevada. Under the direction of the Smithsonian Institution Judge J. G. Swan, of Portland, Oregon, has made a very interesting collection, illustrating the arts and industries of the Indian tribes, both of Western Oregon and Washington Territory. The Signal Service Corps, under the able direction of General Albert J. Meyer, is making rapid advances toward a complete knowledge of the conditions and causes of the American climate. It has nearly completed the most extensive collection of altitudes of places in North America which has ever been gathered. The list includes several thousand profiles, representing almost every railroad and canal. From this and other data it is making a relief model of North America on a large scale.

The Arctic event of the year has been the return of the English expedition, the Alert and the Discovery, under Sir George Nares, from the attempt to penetrate the Pole by the way of Smith's Sound. Regarded from a geographical and scientific point of view, the expedition was a success. I said in my annual address several years ago that to reach the Pole was not the main object in an Arctic expedition; that that was a mere geographical feat, to which necessarily great *éclat* would be attached; but that the real object of such an expedition was to explore the Arctic region in every direction, as far as possible, to obtain scientific in-

formation in a quarter of the globe where it was of the highest interest not only as respects the past physical history of the earth, but to enable us to unravel phenomena and obtain a knowledge of physical laws affecting its present condition which are of high scientific value, or, to express it in a popular form, of the greatest practical importance. This object has been to a considerable degree advanced by this English expedition. The Alert not only attained the highest latitude — 82° 24′ — ever reached by a vessel, and the sledge expedition, under Commander Markham, the furthest northern point reached by man, — 83° 20′ 26″ N. lat., but the expedition, in an unknown region, discovered and traced a line of coast extending over nearly fifty degrees of longitude, ascertained to a considerable extent the nature of the Polar Sea bordering this newly discovered coast, and collected a large amount of scientific information in the examination of both land and sea.

The rivers, coast, and interior of Western Africa have been explored by Beaumier, Tissot, Bonnat, Brazza, Marche, Duparquet, Lux, and others. The most important event in Africa of the year has been the circumnavigation of the Mwutan Nizige (Albert Nyanza), by M. P. Gessi, a member of Colonel Gordon's organization, who estimated the lake to be one hundred and forty miles in length by fifty in breadth. Its banks were clothed with a dense forest, the western side was mountainous, and the southern end shallow. This exploration establishes the connection between this lake and the Nile. From united statements of Gessi and Colonel Gordon, very recently received, it appears that the White Nile is navigable the whole way from Dufli to the lake, a distance of one hundred and sixty-four miles. About twenty miles south of Dufli the river widens, the current is less rapid, and from there to Magungo (on the lake) the river is nothing more than a part of the Mwutan Nizige. This river or expansion of the lake is broad, deep, and filled with islands of papyrus which make the banks difficult of approach. About one hundred miles from Dufli there is a large branch of the river extending north-northwest in the direction of the Nyam-Nyams.

Mr. Stanley, after exploring the west and southwestern shores of Lake Ukerewe (Victoria Nyanza), started from Dumo on its western shore and crossed the country of Unyora to the Mwutan Nizige (Albert Nyanza), and reached that lake at a point where a deep gulf (Beatrice Gulf), formed by a promontory colled Unsongora, runs out for thirty miles in a southwesterly direction. In his journey Stanley saw a mountain southeast of the Mwutan Nizige, which was reported to be from thirteen thousand to fifteen thousand feet high, called Gamboragarè, on the peak of which snow is frequently found. The exact position of this camp on the lake, as given by him, is 31° 24′ 30″ E. long., and 0° 25′ 6″ N. lat. Stanley, when last heard from in July, was on his way to Unamyembi, his intention being to proceed to Ujiji to explore Lake Tanganyka, and then endeavor to strike north toward the

Mwutan Nizige. An object of geographical interest at present is the great island of New Guinea, which, notwithstanding its magnitude, its fruitfulness, and position in the great ocean highway in which it is placed, was thirty years ago put down in the geographies as a *terra incognita*, or, as the geographer Murray expressed it, "viewed only by navigators at a distance." During the last five years it has been the scene of active explorations by Beccaria, D'Albertis, Moresby, Rosenberg, Maclay, the Russian explorer, Macleay, the English explorer, Macfarlane, Stone, and others.

MICROSCOPY.[1]

San Francisco Microscopical Society. — At the annual meeting of this society, held February 1st, the President, Prof. Wm. Ashburner, gave the usual annual address, in which he summed up with more than usual directness and precision the last year's progress and present standing of the society. The excellent financial condition was mentioned as a cause of increasing gratification and encouragement. The society comprises at present thirty resident, ten life, five honorary, and forty-one corresponding members; the resident membership being one less than last year, while the active membership, including resident, life, and those of the honorary members who reside in San Francisco, now aggregates forty-four, or three more than at the date of the last report. This very satisfactory condition has been attained without any effort to increase the membership. The only honorary member elected during the year was Mr. H. G. Hanks, one of the founders of the society and its president during the first three years. During the year twenty-three meetings were held without one failure for want of a quorum, with an average attendance of between eleven and twelve, or the same as the previous year, while the attendance of visitors was less than before. At the annual reception nineteen members participated and two hundred and eighty visitors were in attendance. The exhibition was notably successful, but the effort to present a somewhat orderly arrangement of objects representing in a proper series the different kingdoms of nature was, owing to want of time for maturing the plan, less fully satisfactory than it is expected to be in future after further labor and study. The library contains two hundred and thirty-seven volumes, an increase of one hundred and three over last year. The cabinet now contains five hundred and twenty-three slides, an increase of ninety-four, the set of animal parasites being especially full and numbering seventy slides. Some interesting apparatus has been acquired by purchase and donation; and the occupation of new and pleasant rooms has made the past year conspicuous in the history of the society. Alluding to the previously reported failure to attain a fully satisfactory result in the way of resolving difficult diatoms, and especially the last

[1] Conducted by Dr. R. H. Ward, Troy, N. Y.

three numbers of the Möller Probe Platte, with the new Tolles objectives, the president states that further experience, and intercourse with experts in this special branch of work, has rendered such resolution so simple and easy as to cause wonder how it ever appeared difficult; and he adds the following very interesting remarks on apparatus and test objects: —

"In justice to Mr. Tolles it should be stated that the fault did not lie with the objective, but rather in our own inexperience, for, in proper hands, by its means, the No. 20, or *Amphipleura pellucida* was immediately resolved, after having procured the finest definition of the two preceding ones. While what I now say relates particularly to the $\frac{1}{10}$th, which has accomplished most satisfactorily all that was claimed for it, I cannot pass over in silence our new $\frac{1}{8}$th immersion, by the same maker. With this objective I have by lamp light frequently resolved the last three diatoms on our balsam plate, which has been pronounced a more than ordinarily difficult one, with an ease and clearness of definition that is wonderful, and far surpasses anything I have before had an opportunity of witnessing. Not only does this glass possess in a superior degree the qualities heretofore claimed only for those having the highest angular aperture, but such is its ample working distance and great penetration, that it answers admirably for investigations upon animal and vegetable tissues, where those attributes are so necessary.

"In speaking as I do with regard to resolving difficult diatoms, I would not have you think that I attach more importance to this matter than it really deserves, nor would I for a moment propose it as an end for anything more than to exercise the student in the manipulation of the microscope. In fact, as problems in mathematics teach the use of figures and quantities while they improve the mental faculties, so this resolution of diatoms, which has been so much decried as being a sad waste of time and energy, gives to the manipulator a skill in the use of his instrument without which no success can be obtained. If our effort were to end after having resolved a few diatoms, I should say our society was anything but a success, and although it might have afforded entertainment to its members for the last five years, it had failed to produce any good or lasting effect. To know how to use the microscope with skill is one thing, but to know what you see with it is another and a far more difficult subject; but it is also one which we have by no means completely neglected. That we have a realizing sense of the importance of this branch, and that our progress has not been entirely in the way of material prosperity, I would present as an evidence the recent formation of a class in microscopy, under the instruction of our librarian, Mr. X. Y. Clark, which, I consider would have been an impossibility a few years ago, when so many of our members were interested in the microscope as a novelty, and, perhaps, without speaking offensively, more as a toy than as an instrument with which to acquire real knowledge and instruction."

Laboratory Work in Microscopy. — Two of the summer courses of instruction in science at Harvard University, this summer, will include laboratory work with the microscope, and special instruction in its use in botanical study, the preparation and preservation of objects, etc. No higher guarantee of the excellence of this instruction can be given than is implied in the fact that the course on Phænogamic Botany is to be given by Prof. Geo. L. Goodale, and that on Cryptogamic Botany by Prof. W. G. Farlow. Each course is of six weeks' extent, and is open to applicants, at a fee of $25.

Printed Labels. — Mr. F. F. Stanley of 40 Pearl Street, Boston, Mass., having made arrangements for the printing of his labels of proper size and style for the usual 3x1 slides, will supply the labels for the accommodation of any microscopist, at the cost of twenty-five cents per one hundred labels of any desired subjects. Labels to match, giving name of preparer, can be furnished at the same price in quantities of not less than one hundred of a kind.

Second-Hand Microscopes. — Any microscopist desirous of obtaining a first-class Zentmayer binocular or a Beck Popular binocular, at a very low price, can hear of an opportunity by addressing the Editor of this Department.

SCIENTIFIC NEWS.

— The Harvard Natural History Society, an association of teachers and students at Harvard University, has offered prizes for essays on subjects connected with the natural sciences, by pupils in high schools, or schools of that grade, public or private. The first prize will be a sum of $25.00 and a collection of geological specimens and models. The second prize will be a sum of $20.00 and a collection of insects. For farther information apply to the secretary, George Dimmock, Cambridge, Mass.

— We have received a Preliminary Announcement of a Scientific Expedition around the World, organized on rather an unique plan, to be conducted by a faculty of ten. There will be accommodations for sixty to eighty students. For farther information we would refer our readers to James O. Woodruff, Indianapolis, Ind., or Prof. W. L. B. Jenney, Chicago, Ill., or Prof. J. B. Steere, Ann Arbor, Mich.

— At its last session Congress made an appropriation of $18,000 for a commission of three skilled entomologists to investigate and report on the ravages of the Rocky Mountain locust and to suggest means for their prevention; to be appointed by the Secretary of the Interior. The commissioners have been appointed, and the board organized under the name of the United States Entomological Commission, with C. V. Riley president, A. S. Packard, Jr., secretary, and Cyrus Thomas treasurer.

PROCEEDINGS OF SOCIETIES.

Iowa Academy of Sciences. — October 6th. Professor Bessey read a paper on Some Observations upon the Growth of Plants, made by Means of Arc-Indicators. Professor Macomber read a paper on The Barometer as an Indicator of the Weather. A List of the *Odonota* of Central Iowa, prepared by Herbert Osborne, was communicated by the chairman.

Professor Bessey read a paper entitled A Case of Selection, pointing out how the relative number of individual plants of blue-grass (*Poa pratensis*), white clover (*Trifolium repens*), and *Panicum glabrum* changed under certain conditions, the first decreasing and the last two increasing under more frequent close cutting.

Also, by the same, Observations on *Silphium laciniatum*, the so-called compass plant. About thirty per cent. of all the leaves of this plant do not deviate more than five degrees from due north; forty-two per cent. deviate less than ten degrees, and ninety per cent. deviate less than forty-five degrees, so that it fully deserves the common name of compass plant.

Academy of Natural Sciences, Philadelphia. — December 12th. Professor Cope exhibited a jaw-bone of a Dinosaurian reptile of the genus *Lælaps*, from the Judith River beds, and described its characters. It was said to be the most perfect specimen of the kind yet found, although the whole jaw was at least a foot longer than the specimen. He added three species of *Lælaps* to those already described from the Judith River beds, making six in all from that locality. Ten species of herbivorous dinosaurs have been described from the same formation. He at first thought the specimen exhibited might be the *Aublysodon horridus* of Leidy, but the anterior teeth differ materially from those of the species named. The name *Lælaps incrassatus* had been proposed by Professor Cope for the form some time since, on the evidence of a few teeth.

A number of specimens of teeth of the other species of *Lælaps* and *Aublysodon* were shown and described. The *Lælaps incrassatus* is the largest species as yet found in the Western beds. A new genus, which was stated to be between the genera *Paronychodon* and *Lælaps*, was described under the name *Zapsilus*.

Professor Cope also exhibited a cast of the interior of the cranium of *Oxyæna forcipita*. The anatomical peculiarities of the *Creodonta* were dwelt upon in this connection. The form of the brain resembled most nearly that of the opossum.

December 19th. Professor Cope exhibited a specimen of the cranium and some other bones of a fossil reptile of the genus *Clidastes*, in a single slab of the Cretaceous chalk which composes Cretaceous number three of the West. The specimen consists, in addition to the cranium, of the atlas and two of the cervical vertebræ, the former exhibiting the four elements of which it is composed.

New York Academy of Sciences. — February 5th. Mr. Henry S. Munroe remarked on prehistoric bronze or copper bells, lately exhumed in Japan, and exhibited specimens.

Boston Society of Natural History. — February 7th. Prof. W. G. Farlow made some remarks on cedar apples (*Gymnosporangium*) and *Rœstelia.*

SCIENTIFIC SERIALS.[1]

Monthly Microscopical Journal. — February. On the Relation between the Development, Reproduction, and Markings of the Diatomaceæ, by G. C. Wallich. Observations on Professor Abbé's Experiments illustrating his Theory of Microscopic Vision, by J. W. Stevenson.

The Geographical Magazine. — February. The South African Republics, by E. G. Ravenstein (with a map). The Abbé Armand David's Travels in China, by A. E. Hippisley. The North Siberian Expeditions. The Temperature of the Atlantic Ocean, by J. E. Davis. The Age of this Earth, by H. P. Malet.

The Geological Magazine.— February. On Two New Palæozoic Crustaceans from Nova Scotia (*Anthrapalæmon Hilliana* and *Homalonotus Dawsoni* Hall), by J. W. Dawson. A Question for Silurian Geologists, by J. R. Dakyns. Considerations on the Flotation of Icebergs, by J. Milne. Notes on Coral-Reefs, by H. Hoskyns. High Level Terraces in Norway, by J. R. Dakyns.

Annals and Magazine of Natural History. — February. List of the Species of Crustacea collected by the Rev. A. E. Eaton at Spitzbergen in the Summer of 1873, with their Localities and Notes, by E. J. Miers. On the Fundamental Error of constituting Gromia the Type of Foraminiferal Structure, by G. C. Wallich.

Annales des Sciences Naturelles. — December 15, 1876. Recherches sur l'Appareil Respiratoire et le Mode de Respiration de Certains Crustacés Brachyures (Crabes Terrestres), par G. Duchamp. Mémoire sur les Métamorphoses des Acariens en général, et en particulier sur celle des Trombidions, par P. Mégnin. Note sur les Oiseaux de la Nouvelle Zemble, par M. Theel. Recherches Expérimentales sur les Functions de la Vessie Natatoire, par A. Moreau. Histoire des Clausilies de France Vivantes et Fossiles, par J. R. Bourguignat.

Bulletin of the American Geographical Society, New York. —No. 2. Addresses by Col. T. B. Myers and Rev. Dr. Bellows at the opening of the Society's building, November 28 and 29, 1876. Spitzbergen Seas and a Boat Journey in Lapland, by A. H. van der Horck. The Republics of South Africa, by Miss Russell. Philosophy of the North American Indians, by J. W. Powell. No. 3. Address of Chief Justice Daly on Geographical Progress in 1876.

[1] The articles enumerated under this head will be for the most part selected.

THE

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VARIATION IN ÆSTIVATION.

BY PROF. W. J. BEAL.

THE great variety of ways in which the sepals and petals of each species meet or overlap each other in the bud is often quite wonderful. In some cases, after examining many flowers, this is found to be true, even in certain species which have been described by some of our best authors as having the parts constantly arranged in a certain definite manner. Take, for example, the diagrams found in Hooker's Le Maout and Decaisne. It would seem as though the artist or the writers of the text, or both, had the idea that sepals and petals were arranged only in a few certain ways, as valvate, convolute, and imbricate in three modes, namely, spiral, opposite in twos, and quincuncial. It would appear by their diagrams that they had been remarkably successful in finding no other forms, or that they had kept throwing away all others as accidental or spurious until those only were found and used which corresponded to their ideal. These remarks will apply with equal force to several other botanical works.

In our best authors on botany, the diagrams showing the æstivation of the sepals of Cruciferæ all appear to be made as they look after the end of the flower-bud is cut off. This shows the sepal next to the axis and the one opposite to it overlapping each edge of the two lateral sepals. There is nothing in such a diagram to indicate that the tip of the anterior sepal overlaps the tip of the posterior. This is the case in all the buds of the several species which I have examined. In the diagrams of all works accessible to me, there is nothing to show that the tip of one of the side sepals overlaps the tip of the other. This overlapping of one lateral sepal was found in all cases examined where the tips were large enough for such purpose. Of fifteen buds of black mustard (*Brassica nigra*) examined, the sepals of

ten, at their tips, showed the left lateral sepal overlapping the right; in the other five the right lateral sepal was outside the left one. In speaking of the right and left sepals of these flowers, I refer to them as they appear when holding the flower before us with the axis of inflorescence away from or beyond the flower. In the hedge-mustard (*Sisymbrium officinale*) the lateral sepals barely meet, making it impossible to tell which would overlap if they were longer. Of ten buds of *Nasturtium palustre*, seven had the right lateral sepal covering the left; and in three, the reverse was true. The æstivation of the petals of the three preceding species was not easy to determine with certainty, as the tips overlapped but very slightly or not at all.

In Chinese mustard, the æstivation of the sepals was variable, much the same as in the other species above noticed. Fifty flowers were carefully examined. I observed the position of each petal with reference to each other petal, and also its position with reference to the axis. Each of the four petals, or a corresponding petal in different flowers, was found outside; each was found inside. Bearing in mind, as I think we ought, the position of each petal with reference to the axis, I found that the petals of fifty flowers were placed in twelve different ways. In the first twelve examined, the petals were arranged in eight different ways, as follows. The dot indicates the position of the axis:—

Fig. 33.

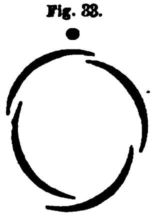



Fig. 34.

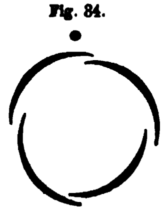



Fig. 35.

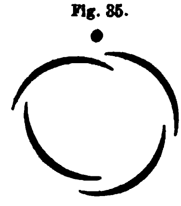



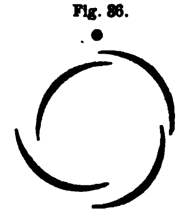
Fig. 36.


Fig. 37.

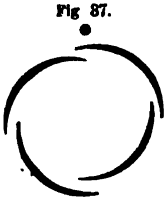



Fig. 38.

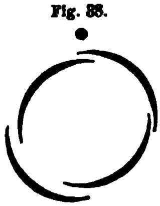



Fig. 39.

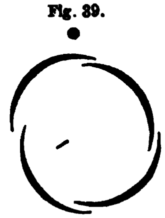



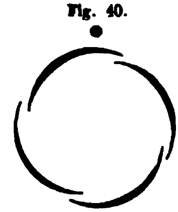
Fig. 40.


Fig. 41.

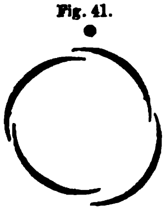



Fig. 42.

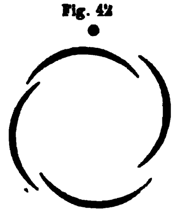



Fig. 43.

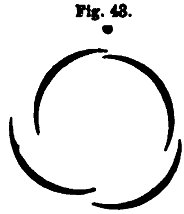
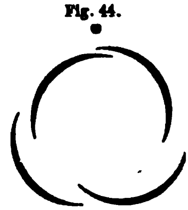
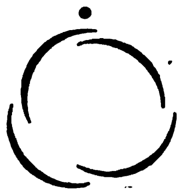



Fig. 44.


Thirteen were represented by Figure 33, six by Figure 34, five by Figure 35, four by Figure 36, three by Figure 37, three by Figure 38, three by Figure 39, three by Figure 40, three by Figure 41, two by Figure 42, two by Figure 43, two by Figure 44, and one by Figure 45.

Fig. 45.



With reference to the Cruciferæ, we find in volume i. of Gray's Genera of North America this sentence: "In æstivation, the petals are imbricated with usually one exterior, two half exterior and half interior, and the fourth wholly interior, or else they are regularly convolute." Le Maout and Decaisne say, "Petals variously imbricate in bud." Bentham and Hooker's Genera Plantarum says, "Petals convolute or imbricated with one exterior and the fourth interior." Neither of the above quotations expresses the arrangement for the order. The first comes the nearest because it is the most general of all.

Instead of twelve modes of arrangement for the petals of the fifty flowers mentioned, no doubt the variations would be considerably increased if the position of each petal were observed in its relation to each sepal.

Cleome integrifolia has four small sepals early open in the bud, variously imbricated. The four petals of one hundred flowers were arranged as follows: —

Fig. 46.

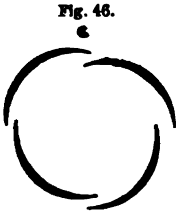


Fig. 47.

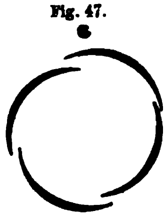


Fig. 48.

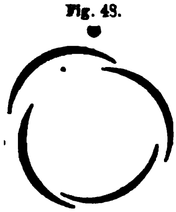
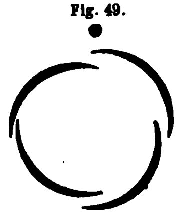
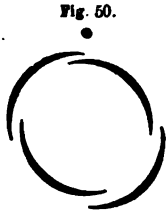


Fig. 49.



Two species of Rosaceæ belonging to two different tribes were examined, namely, *Spiræa urticifolia* and *Agrimonia Eupatoria.* The Spiræa noticed has valvate sepals. The pedicels are too long to make it easy to discover which sepal is next to the axis. The tips of the petals overlap each other in the bud, making it quite easy to determine their relative position. Thirty-three buds were examined, showing fifteen different combinations or sorts of æstivation for the petals, without taking into consideration the position of each with reference to the axis. None were valvate nor regularly convolute, yet, I doubt not, they may be found.

Fig. 50.



Calling the outer petal number one, the next outside number two, and so on, I can show their position as follows by numbers which are here shown as we come to them passing around the flower to the right: —

In 2 flowers the petals formed a spiral to the right	1, 2, 3, 4, 5.
In 2 " " " " " left	1, 5, 4, 3, 2.
In 5 " " stood thus	1, 4, 5, 3, 2.
In 4 " " were quincuncial to right	1, 4, 2, 5, 3.
In 3 " " " " left	1, 3, 5, 2, 4.
In 3 " " "	1, 2, 4, 5, 3.
In 3 " " "	1, 3, 5, 4, 2.
In 2 " " "	1, 5, 4, 2, 3.
In 2 " " "	1, 3, 2, 5, 4.
In 1 flower " "	1, 2, 5, 4, 3.
In 1 " " "	1, 4, 3, 5, 2.
In 1 " " "	1, 2, 3, 5, 4.
In 1 " " "	1, 3, 4, 5, 2.
In 1 " " "	1, 5, 4, 3, 2.
In 1 " the four petals were	1, 4, 3, 2.
In 1 " " " "	1, 3, 4, 2.

In *Agrimonia* it was very easy to determine the relative position of each sepal and petal, and also the same with reference to the axis. Taking all these things into consideration, of sixteen buds examined closely only two were alike. Undoubtedly there were still many other variations. The five sepals in each case were quincuncial; in eight the spiral went to the right; in eight the spiral went to the left. In all cases observed the second sepal was next to the axis. Of the petals two were arranged in quincunx: with one of these the spiral turned to the right; with the other to the left. The petals of one were convolute; one spirally imbricated to the right, thus, 1, 2, 3, 4, 5. The rest were imbricated in various other ways.

Dr. Gray, Bentham and Hooker, and others speak of the petals of the *Onagraceæ* as convolute (contorta) in the bud. The majority of cultivated fuchsias are not convolute in æstivation.[1]

Of five hundred and seventy-nine buds of *Epilobium angustifolium* the petals of two hundred and eighty-five are convolute, turning to the left, and one hundred and fifty-four to the right. Fifty-three had a single spiral turning to the left, and fifty-three to the right. In twenty-three, two opposite petals covered both edges of the other two. In eight flowers one petal was exterior, one interior, and the other two petals of course were alike half-covered and half-covering. In three flowers one petal was outside and the other three were convolute.

[1] See note in American Naturalist, page 110, 1876.

Of thirty-eight buds of *Œnothera biennis* thirty were convolute to the right; three buds had one petal outside and the rest spirally turned to the right; two buds had one petal outside and the rest spirally turned to the left; two buds had one petal outside and its opposite one inside; one bud had one petal outside, the numbers running thus, 1, 3, 4, 2, to the right.

Of the order *Asclepiadaceæ* with reference to æstivation Dr. Lindley in Vegetable Kingdom says, "Æstivation of corolla imbricated, very seldom valvular." Dr. Gray in his Manual of Botany, last edition, says, "This order has commonly a valvate corolla which separates it from *Apocynaceæ* which has a convolute corolla." In the *American Journal of Science*, November, 1875, Dr. Gray says, "The type of the latter [*Asclepias*], and the common disposition when the parts are five, is with two pieces exterior, the third exterior by one edge and interior by the other, and two wholly interior." In other words, the petals are quincuncially arranged, the same as alternate leaves on the stem of a cherry-tree. Le Maout and Decaisne say, "Corolla usually contorted." Robert Brown, who gave especial attention to this order, says, "Æstivation of corolla imbricated, rarely valvate."

My first supposition was that I had examined a lot of exceptions to the general rule as stated by such good authority as Gray, especially as it is given as a distinctive mark to separate two related orders. On examining the other authors, I venture to give the results of the number of buds and the name of the species examined.

At the first glance, the corolla of *Asclepias* and *Acerates* seem to be valvate in the bud, but on looking closer, all I have seen are unmistakably convolute.

The petals of	thirty	buds of	*Asclepias*	*incarnata*	were	convolute	to	right.
"	five	"	"	*variegata*	"	"		"
"	five	"	"	*tuberosa*	"	"		"
"	five	"	"	*purpurascens*	"	"		"
"	five	"	"	*phytolaccoides*	"	"		"
"	five	"	"	*Cornuti*	"	"		"
"	seven	"	"	*verticillata*	"	"		"
"	five	"	*Acerates*	*viridiflora*	"	"		"

The results, it will be seen, correspond with the account of Le Maout and Decaisne. Probably, Dr. Gray bases his description on other species than those to which I have referred.

In the order *Apocynaceæ*, of forty-three buds of *Apocynum androsæmifolium*, I found the petals all convolute to the right. Five buds of *A. cannabinum* were the same. In nine buds of the former, the sepals were quincuncial to the right, in five buds

quincuncial to the left. The other buds of that species were not observed. In the latter (*A. cannabinum*) four buds showed the sepals quincuncial to the left, and one to the right.

It will be observed that the æstivation of *Asclepias* and *Apocynum* are the same, at least so far as the specimens examined are concerned.

In the *Rubiaceæ*, of one hundred and fifty buds of *Cephalanthus* I found that eighteen were convolute, thirteen to the right, three to the left. In Genera Plantarum of Bentham and Hooker, in the tribe containing this species the text says, "Petals never contorted" Keeping in mind the position of all the petals as they stand with reference to each other and to the axis, and noticing the direction of the spirals, I found the petals of thirty-seven buds arranged in twenty-three different modes.

Each of the four petals was found to be outside, each inside, and each occupying either of the intermediate positions.

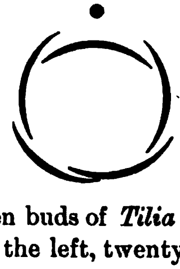
If we disregard the direction of the spiral and the position of the axis, these twenty-three modes are reduced to six modes.

In the same order, one hundred buds of *Galium asprellum* were all valvate.

Malvaceæ: In four hundred and thirty-three buds of *Malva rotundifolia*, two hundred and one petals were convolute to the right, two hundred and four to the left, fifteen quincuncial, and thirteen as in Figure 31. Lindley and Gray speak of the petals of this genus as convolute.

Fig. 31.

Fig. 32.



Tiliaceæ. In one hundred and seven buds of *Tilia Americana*, fifty-nine were quincuncial, turning to the left, twenty-four to the right, thirteen as in Figure 32; eight had one outside, and then the rest turned spirally to the right. Three were convolute to the left.

Oxalis stricta. Of nineteen buds, ten had the sepals quincuncial to the right, nine to the left. In twelve of these buds the petals were convolute to the right, in five to the left, in one spirally to the right, in one a still different mode.

In *Scrophularia nodosa*, the sepals are imbricated in various

modes and some are convolute. In buds of the irregular corolla, the two upper lobes cover the others. In twelve out of nineteen buds, the left lobe of the two outer lobes was outside; in seven the right lobe was outside. It is not easy to determine which is number three and which number four, both covering number five. Of over one hundred flowers of *Phlox Drummondii*, all had the lobes of the corolla convolute to the right. By cultivation and selection for some years, we have numerous permanent varieties or races showing a great variety in color, size, etc., but the æstivation shows no signs of change. I found in one hundred buds of perennial phlox the lobes of the corolla were all convolute to the right. Of over one hundred flower-buds of *Lobelia cardinalis* the lobes of the corolla were all valvate.

From the foregoing examples, I judge that enough attention has not heretofore been given to some of the forms of æstivation which have been thought uncommon. Each sepal and petal should be observed with reference to each other sepal and petal and the axis or bract; also the direction of the whorls or spirals, whether to the right or to the left. The tips of the flower-buds should not be cut off before observing them for diagram or description. Some species are quite constant as to mode, but vary in direction of spirals; others are constant in mode and in direction; others vary as to which sepal or petal is outside the rest. I have introduced no new names to express some of these modes of æstivation, nor have I used all those which others have proposed. In some cases I have preferred to number the outer sepal or petal one, the next within two, and so on till all are numbered. Then begin with number one and place the numbers in a horizontal row as they occur, passing always to the right as the flower is held before the observer. This mode would be of much greater value if we could always tell with ease which sepal or petal was next to the axis or opposite to it. Many authors have copied errors from each other. These errors have, doubtless, many of them been made, authors giving general or definite rules after examining only a few specimens.

As æstivation varies so much where it has been thought so constant, often even in the flowers on the same plant, it seems to me there has been too much stress placed upon certain modes; that it renders of less value the efforts of Jussieu and others to explain or harmonize the quincuncial with other kinds of æstivation. Perhaps we have placed too little stress upon some trivial circumstance or accident in deciding the mode of æstivation in any particular flower.

STONE IMPLEMENTS AND ORNAMENTS FROM THE RUINS OF COLORADO, UTAH, AND ARIZONA.

BY EDWIN A. BARBER.

IN my two preceding papers relative to the Ancient Pueblos of the Pacific slope of the United States, the first in the August number of The Naturalist and the second in the December issue for 1876, I have described some of the pottery and rock etchings of an exceedingly old American race. I shall strive to convey some idea, in this paper, of the tools which were employed by the same people in the manufacture of articles and in the erection of their stone houses. Some of the specimens herein figured I believe to be unique, but this cannot be ascertained to a certainty without examining every collection of western antiquities.

Stone implements and utensils are so numerous throughout the section of country formerly occupied by the Ancient Pueblos, that for the sake of convenience in describing them I will separate them into two divisions, calling them objects of warlike or peaceful vocations. Thus we have —

Weapons:
- Arrowheads (of war[1] and the chase).
- Spear or lance heads and darts.
- Battle-axes or tomahawks.
- Arrow polishers or straighteners.

Implements:
- Hammers and Mauls.
- Axes.
- Knives.
- Saws and chisels.
- Awls, "rimmers" or borers.
- Skin scrapers, or "fleshers."
- Mortars and pestles.
- Millstones (*metates*) and grinders.
- Pierced pottery and stones for drawing out sinew (gauges).
- Meat pounders.

Because it is an indisputable fact that great battles have been

[1] The greater number of the war arrows, I think, are undoubtedly of Ute origin, having been projected into the midst of the ancient towns, but some, at least, are the productions of the *besieged*, although they were eminently a peaceful people. We would not expect to discover these weapons of the Pueblo race, however, immediately under the walls of their own buildings, but rather further out on the plains. The majority of our specimens were found in the close neighborhood of the mural remains.

fought here, we would expect to discover large quantities of the utensils of war, and indeed we find this to be the case, as they abound in the vicinity of all of the greater ruins and many of the lesser.

(Fig. 51.) Natural Size.

The arrowheads are particularly noticeable on account of their delicacy, perfection, symmetry, diminutiveness (see Figure 51), and exquisite coloring.

They surpass anything of the kind ever discovered in any other portion of the United States. In a single locality is frequently found the greatest variety of forms, and two are seldom picked up of the same material. Figures 10 a, b, c, d, e, f, g, and h, Plate I., show some striking forms. We find them varying from less than half an inch in length to three inches. Sometimes we find a beautiful, transparent, amber-colored chalcedony specimen, while our next discovery may be a delicately fashioned point of obsidian. Here we discover a flesh-colored arrowhead made of agatized wood, while there we see another of a light pea-green tint. Red-jasper specimens seem to predominate, however, or are at least as numerous as those of flint, of which we find every shade of color. According to form, the arrowheads of this country may be classified into nine divisions, as follows: —

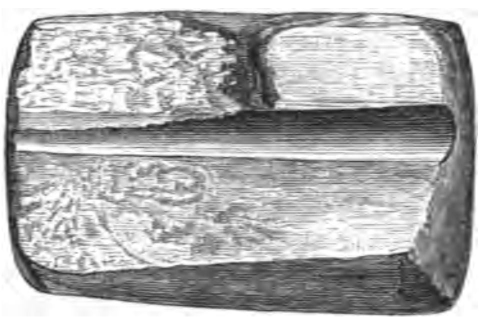
(1.) Those which are *leaf-shaped;* (2), those which are *triangular;* (3), those which are *indented at the base;* (4), those which are *stemmed;* (5), those which are *barbed;* (6), those which are *beveled;* (7), those which are *diamond-shaped;* (8), those which are *awl-shaped;* and (9), those having the shape of a serpent's head. Of course these forms are subject to modification, and often one runs into another.

The materials are agate, jasper, chalcedony, flint, carnelian, quartz, sandstone, obsidian, or silicified and agatized wood. Among the relics of battles the barbed heads are the most common, while the leaf-shaped varieties occur more numerously at a distance from the ruins on the plains, where they have been employed in the slaying of game.

It will be immediately seen why this distinction in the selection of missiles was made. The leaf-shaped or diamond heads could be readily withdrawn from the bodies of animals and used again, while the shaft of the barbed varieties could not be extracted from the body of a human victim without leaving the point in the flesh to produce inflammation and probably death. The larger sizes may have been used on the points of lances or

spears, as they are too clumsy and heavy to have been employed in conjunction with the bow.

The smaller varieties of axes may have been used as tomahawks in war. Under the head of weapons I have placed the *arrow-straighteners* or polishers, although they may more properly be classed with the second division, as they were not used either for offense or defense, but only for polishing or straightening the wooden shafts of arrows.[1] We found but one specimen, or rather the *half* of one. This instrument originally consisted of two flat stones about three inches long, two inches wide, and half or three quarters of an inch thick. These were ground smooth on the faces so as to fit accurately together, and through one end of the united halves was bored a circular hole, penetrating to the other end. Half of this orifice lay in each stone. The wooden shaft was laid horizontally in one stone and the other fitted over, and by drawing the stick in and out it was polished and straightened. (See Figure 52.) This specimen is made of a coarse, pink sandstone.



(FIG. 52.) ARROW-STRAIGHTENER. (Natural Size.)

The latter class, or *household implements*, though not so numerous, we found more widely distributed than the former. These were scattered through all of the ruins, the majority crudely made, but some of them smoothly polished and ground to a cutting edge.

The edges of the latter class of stone axes were kept in order by abrasion or by rubbing them down on stone whenever a notch was accidentally made. Sometimes this laborious process occupied days, and a single careless blow with the axe might destroy the results of many hours of labor. I noticed along the sloping surface of the narrow ledge of sandstone on which was built the *Casa del Eco*, a ruin on the San Juan, several rounded depres-

[1] For an illustration of a similar tool refer to Evans's Ancient Stone Implements of Great Britain, page 241.

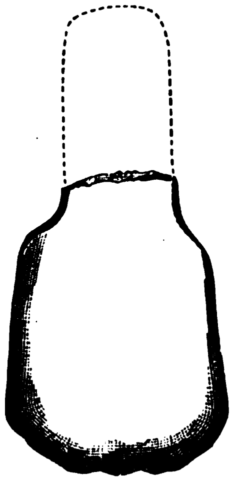
sions, a couple of inches deep in the centre, about four inches wide throughout, and perhaps six or eight in length, which were undoubtedly the results of this artificial process of attrition. Here, I am satisfied, beneath the walls of the houses the ancient laborers stepped out to sharpen their awkward stone tools.

In Plate I. may be seen a peculiar form of axe (Figure 5). It has seen much service, and is furnished with a groove for the attachment of a handle. This specimen was found at a ruin near Abiquiu, N. M., and is made of a light-colored chloritic schist. It is three inches in length. A number of forms of hammers and mauls were discovered, varying in weight from a few ounces to twenty-five pounds. Figure 53 shows an unusual form of a stone hammer obtained in the Moqui towns of Arizona. The man from whom I purchased it informed me that it had been handed down from generation to generation, and had been used by the old fathers of the tribe long before iron was introduced among them by the whites. It is made of a hard, greenish porphyritic rock containing iron, which is seen streaking the sides of the implement. The stone is similar to the *verde antique* of the ancients.

(FIG. 53.) HAMMER OF PORPHYRY.

Great mauls weighing twenty pounds and over were used by the Ancient Pueblos, though for what purpose it is difficult to imagine; they must have required more than one pair of hands to wield them. These were usually made of compact sandstone, and were cylindrical, with the groove for the handle extending around the circumference near one end. The striking end was frequently terminated conically. There was also the flat, water-washed cobble of the river, which was similar to many of the axes, excepting that it had not been ground to an edge, but was used in a blunt state for pounding. Some of the hammers were ovoid, with the groove extending around the centre, so that either side could be used at will. Several beautifully shaped and polished fleshers, or skin scrapers, were picked up by the party along the San Juan River. These are about six or eight inches in length, with the broader end sharpened. They are made of smooth, fine-grained stones, such as jasper or silicified wood, although I found a portion of one which was a chocolate-colored slate. Mr. Holmes, in the Mancos Cañon, observed the end of one protruding from the floor of a ruin, and upon drawing it

from the soil found it to be a very perfect specimen, but stained black over the portion which had been buried.[1] The only use to which such tools could have been devoted was the tanning, cutting, or scraping of hides and skins. Another curious form of the same may be seen in Figure 54, whch is probably unique. This is made of a bright-yellow jasper; it is ground flat and



(FIG 54.) FLESHER OF JASPER.

(FIG. 55.)

smooth on each side, and is scarcely a third of an inch thick. The end of the handle is wanting. I can conceive of no use for which this spatulate instrument could have been intended except skin-dressing. The edges are blunt and rounded, and it *may* have been employed in culinary operations as a spoon or ladle.

Numerous serrated implements were picked up among the *débris* of the ruins, of different sizes and forms, which were evidently intended for sawing. The fragments of some indicated that the entire instrument had been several inches in length and an inch or so broad. One, however (Figure 55), was a circular stone of a bright-green color, in which the entire circumference (with the exception of a small arc) had been toothed or chipped. This was probably used in the same manner as the straight saws, being held between the finger and thumb.

Chisels, awls, borers and rimmers occur in abundance. The chisels or pointed tools were probably used in chipping out hieroglyphics. The awls, borers, and rimmers were employed in perforating skins, wood, stone, etc.

Among the pottery and pendants may be seen holes made by

[1] See Figure 3, Plate I.

these instruments. One opening of the orifice is small, while the other is larger and funnel-shaped, revealing concentric rings, showing that the tool with which they had been bored tapered gradually to a point. On account of the delicate nature of these, it is seldom that a perfect one can be found, but Figure 56 represents an unusually delicate specimen picked up on the Rio de Chelly. It is shaped like a horseshoe nail and chipped from a perfectly white stone.

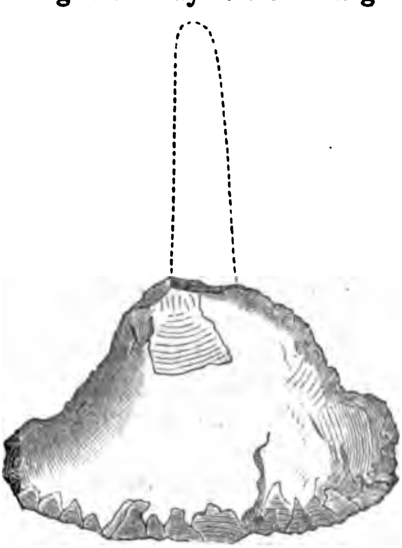
(Fig. 56.)

Stone mortars are rare in a state of entirety, yet we found many fragments scattered over the plains and through the cañons. The prevailing material seems to have been sandstone; pestles are very rarely seen. However, in the Moqui village, I observed several stone mortars, some eight or ten inches in diameter, with their accompanying pestles, which had been placed on the house tops, and I was told that they had not been in use for many years, having descended with many old stone implements from the forefathers of the tribe.

One of the most common objects to be found in and about the crumbling buildings is the millstone, or *metate*, and with it the corn grinder. Lieutenant Emory says of the ancient remains along the Gila River: "The implement for grinding corn and the broken pottery were the only vestiges of the mechanical arts which we saw amongst the ruins, with the exception of a few ornaments, principally immense well-turned beads, the size of a hen's egg." A good specimen of a grinder may be seen in Figure 4, Plate I.: it is made of black cellular basalt, found near Ojo Caliente, N. M.

The great numbers of pieces of perforated pottery and small stones were used in two ways: some were intended for ornamenting the person, while others were doubtless used for drawing out sinew for bowstrings and thread.

Other implements were discovered whose uses have not been determined, such as Figure 57. I picked up several polished stones of a pink color, ground down flat on each side. These were a couple of inches



(Fig 57.) STONE IMPLEMENT WITH SHARP EDGE.

in length and an inch in width, but whether designed for some ornamental purpose or whether used as implements of some kind, I am unable to say. Figure 1, Plate I., is a specimen of basket weaving found in one of the ruins of the Mancos, but I am inclined to think that it is not of very ancient workmanship, but was most probably carried there by some roving Indian who belonged to a more recent tribe. Yet it is not improbable that this had been woven centuries ago, for it is made of a species of rush (*Scirpus validus*) which occurs abundantly on the banks of the stream, and this kind of vegetable matter, containing, as it does, a considerable amount of silica, might remain perfect in sheltered locations for an indefinite period.

Figure 2, Plate I., illustrates a bundle of sticks which was found buried beneath a pile of rubbish in a cliff house of the same cañon. These sticks may have been used in some game. Such objects are employed at the present day by several Indian tribes. The Utes use them in gambling, each one counting a unit. As they are won they are stuck in the ground in front of the player, and he who succeeds in winning all the sticks gains the stakes. These pieces of wood have been sharpened at one end by rubbing on stones. Mr. Holmes, who discovered them, says, "The bit of cord with which they are tied is made of a flax-like fibre carefully twisted and wrapped with coarse strips of Yucca bark; beside this a number of short pieces of rope of different sizes were found, that for beauty and strength would do credit to any people. The fibre is a little coarser and lighter than flax, and was probably obtained from a species of Yucca which grows everywhere in the Southwest."

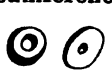
Among the personal adornments of most aboriginal tribes of men are found many varieties of beads which have been cut or ground from wood, bone, horn, stone, claws, and teeth of animals, or shells. Those made of various species of the latter predominate, the marine shells, such as the *Busycon*, *Marginella*, *Oliva*, *Fasciolaria*, and many other genera (usually *univalves*) being the most common. The prehistoric people of Arizona, New Mexico, Utah, and Colorado employed, in the decoration of their persons, at least *two* genera, of which several species were discovered by the photographic division of Hayden's United States Geological Survey.

All the bead ornaments found in this section of the West may be classed under four heads: —

I. Shells.

II. Earthen-ware beads.
III. Turquoises.
IV. Pendants.
(A, of stone ; B, of pottery.)

The marine shells which were converted into beads by the ancient tribes, so far as has been ascertained by the investigations of the United States Geological Survey, during the summer of 1875, were the *Oliva* and (possibly) the *Busycon*, or *Murex*. Of the former genus we were so fortunate as to discover at least one species. Figure 7, Plate I., represents a specimen of the *Oliva biplicata* (probably), although the shell[1] is so weather worn that the specific characteristics are almost entirely obliterated. Still, it strongly resembles this species of the Pacific coast, and is very likely the same. This size, however, was not so common as a larger variety which is, in all likelihood, a more fully developed representative of the same species. The first samples of these shell beads were taken from the site of an old ruin where they had been lying for many centuries, until they had become entirely decomposed. Through Eastern Utah and south into Arizona many Olivas were found scattered through the *débris* of crumbling walls and broken pottery. The perforation has been effected by grinding down the apex so that a thong would pass through the shell lengthwise. Of the genus *Busycon*, or *Murex*, was found but one doubtful example. The beads made from this were of two sizes and usually white. The smaller variety was flat on both sides, or slightly convex on one side and concave on the other (Figure 58), as thin as a wafer, and the circumference of an ordinary pea. In the centre a neatly bored hole enabled the owner to string them together in the form of a necklace. The larger variety was about the circumference of an average buck shot. Such beads were evidently held in great esteem by the wearers, and among the ruins they are extremely rare, only a few specimens having been found. Captain John Moss, of Parrott City, Col., says that these beads are valued highly by the present Navajo Indians to the south, a small string, when such can be found, bringing in exchange a good horse. The Navajoes are constantly grubbing about the old buildings and adjacent graves in search of these trinkets; this accounts in some measure for their great scarcity among the ruins to-day. They were undoubtedly obtained by the ancients from other tribes who brought them, or at least the

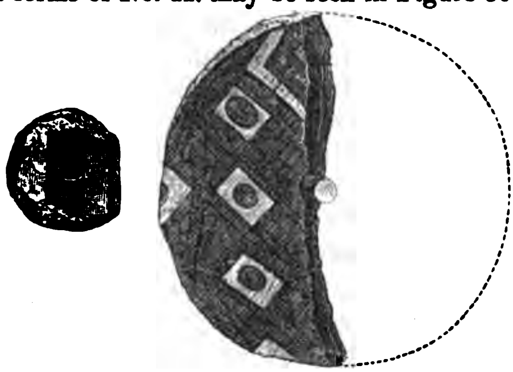


(Fig. 58.)

[1] It may be *Olivella gracilis*.

shells from which they were fashioned, from the Pacific coast. We know that these ruins extend as far west as the junction of the San Juan and Colorado rivers, so that communication between the tribe in question and others situated along the Pacific Ocean or Gulf of California was rendered easy. Don Jose Cortez, writing of the tribes near the Colorado, in 1799, speaks of "the white beads they get on the shores of the Gulf of California."

Of the second class of bead ornaments, many are found among the heaps of ancient pottery which surround the majority of the old ruined buildings. A small piece of pottery, generally of the best glazed and painted ware, is selected, and the edges ground down into a circular or rectangular form varying in size from a third of an inch to two inches in diameter, or from a half inch to an inch and a half in length. The circular specimens have perforations in the centre, while the square or rectangular varieties have holes near one end. These latter may be classed with No. IV. Some forms of No. II. may be seen in Figure 59.[1]



(FIG. 59.) ANCIENT INDIAN POTTERY. (Natural Size.)

The third division is represented by but a single specimen, which was picked up during the month of August, 1875, in the Cañon of the Montezuma, in Utah. It is simply a piece of turquoise flattened and polished on both sides, and is undoubtedly half of a small plate or bead, as is demonstrated by the orifice, at which place it has been divided. The hole was evidently bored by a stone rimmer, as the opening on the upper surface is much greater in diameter than that on the under. This interesting relic measures about a third of an inch across its greatest diameter. Turquoises, the "*chalchihuitls*" of the Aztecs, were obtained from the Los Cerillos Mountains, in New Mexico, southeast of Santa Fé. Here is a quarry which was worked before the arrival of the

[1] The largest of these mav have been designed for spindle whorls.

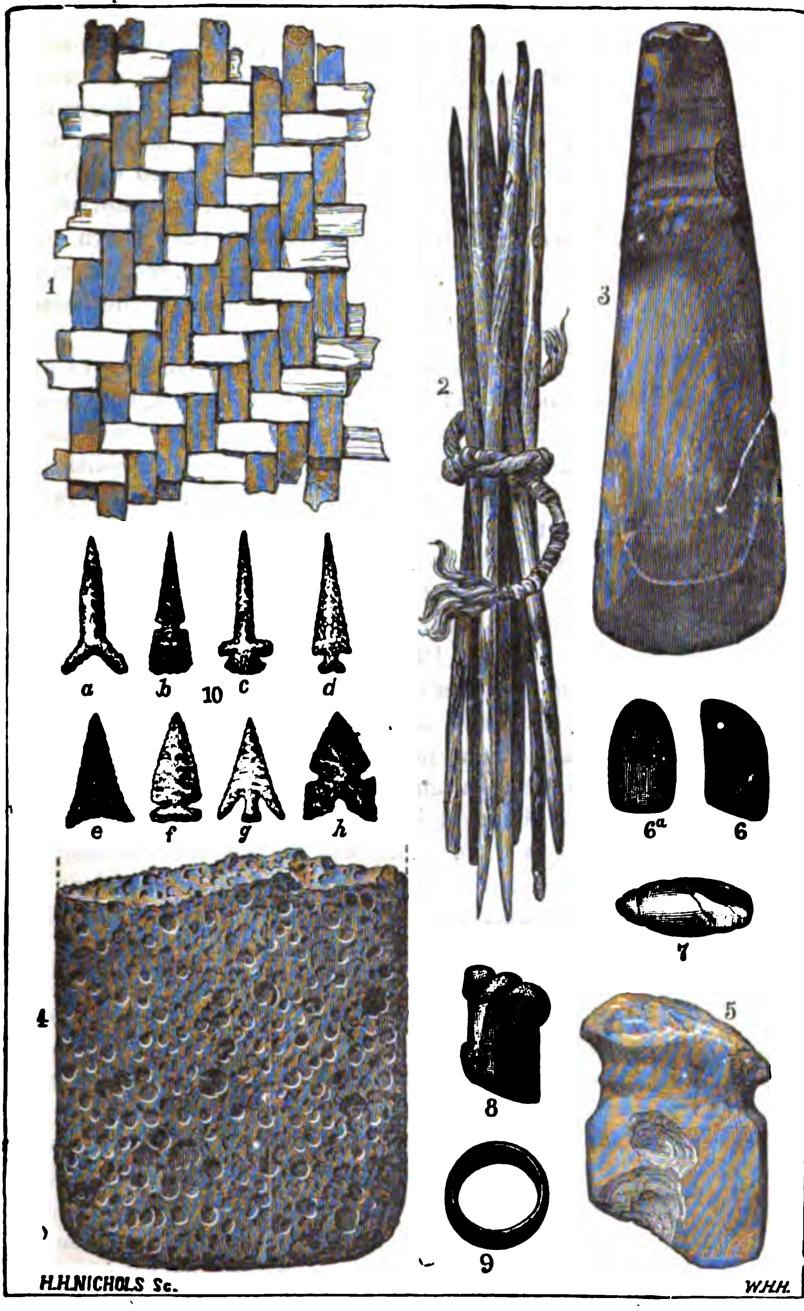


PLATE I.

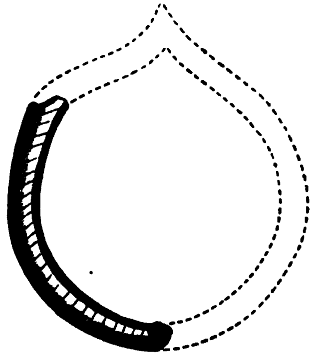
Spaniards in the country, and it was here, undoubtedly, that the ancient "cliff-dwellers" obtained their turquoise. Here, probably, their descendants, the Moquis, Pueblos, and Zuñis, procured the turquoises mentioned by the Reverend Father Friar Marco de Niça in 1539, and by Francisco Vasquez de Coronado in his account of his visit to these people in 1540. Marco de Niça wrote: "They have emeralds [1] and other jewels, although they esteem none so much as turquoises, wherewith they adorn the walls of the porches of their houses and their apparel and vessels, and they use them instead of money through all the country."

The fourth and last class of bead ornaments consists of all those trinkets made usually of stone or silicified wood, but occasionally of pieces of pottery which were employed in decorating ear-rings or necklaces. These are usually flat, neatly polished, rectangular pieces, with the aperture in one end. They vary from half an inch to two inches in length, the width being usually about two thirds of the length, and from one sixteenth to one eighth of an inch in thickness. The form graduates from the rectangular to the elliptical, as the corners are more or less rounded. Figures 6 and 6a, Plate I., represent two of these ornaments, an inch and a quarter in length. These were suspended either from circular ear-drops, made mostly of shells, or from the front centre of necklaces, and in some cases may have been worn at the nose. Some such ornaments as these are still employed among the Yampais, Pimas, Mojaves, Moquis, Pueblos, and Zuñis of Arizona and New Mexico. This style of perforated ornament was the commonest, and the specimens are the most abundant of all the varieties which may be classed among the *bead work* of the ancient people of the West. They include all such objects as pendants, "gorgets," ear-drops, and nose ornaments, usually made from silicified wood, though occasionally from a white, fine-grained limestone.

The shell ear-rings were manufactured with much labor, and used by the same people. One single fragmentary specimen was discovered by the party, but it is sufficient to show its use, and was probably a representative of an ordinary form. (See Figure 60.) The circlet was cut from a whorl of a marine shell, most likely the *Murex*. As shown by the arc of the circumference of the specimen, itwas originally about one and five eighths inches in its outer diameter. To such attachments as this the pendants

[1] Chrysolite, probably.

of Class IV. were suspended. Another, similar to this but larger, which was found at the Casa Grande (Chichilticale), on Rio Gila, is figured by Lieut. A. W. Whipple in his report. One specimen of a finger ornament was found by Mr. Holmes's party. It represents a *stone* ring about five eighths of an inch in diameter, made of hard, gray slate. This may be seen in Figure 9, Plate I.



(FIG. 60.) INDIAN SHELL EAR-RING.

The perforations in the pendants are drilled, some of them from each side, meeting at the centre, while in others the boring has been done entirely from one side. In the majority of cases the orifice is funnel-shaped, but occasionally we meet with a piece of pottery in which the perforation is of the same diameter throughout. This neat puncturing must have been accomplished with superior stone awls or borers. In some specimens of pendants the hole has been started and sunk half way, but not completed. Figure 61 illustrates a very pretty charm or chain ornament (possibly a *totem*) made of a white stone. It represents an animal of some kind, is cylindrical, and was probably worn at the neck; it may have been a sinker. This is the only object of this kind found throughout this country, with the exception of a carved figure (Plate I., Figure 8). Several pieces of white wampum were also picked up near the mouth of the Rio de Chelly, but they were not drilled hollow. They resembled pieces of solid pipestem about an inch in length, and had either been cut from a thick shell or were fashioned from a white stone.

(FIG. 61.) AMULET OR PENDANT.

We see, then, that the ancient Pueblos devoted much time and labor to the production of objects for the decoration of the person, and in this respect they displayed much ingenuity, and their surviving ornaments reveal to us some degree of the vanity with which they were endowed.

GLIMPSES OF MIND IN BIRDS.

BY DR. CHARLES C. ABBOTT.

ON the morning of the 20th of December, 1876, a large flock of small sparrows was seen to pass over my house and settle down in the old oaks immediately beyond. There they remained and chattered for fully an hour, when with one accord they all took flight and sped on their way southward. There was no need of destroying the lives of any of these joyous songsters, for they were so very tame that they were easily recognized while busily flitting through the then ice-covered twigs of the oaks. They were the common tree-sparrows (*Spizella monticola*). I was so much struck with the peculiarity of their movements, in the dual circumstance of migrating in company and in their close proximity while on the wing, — two conditions I had never before noticed with reference to this sparrow, — that I started out for a day in the field, to see if other birds were to be found migrating by day, as though endeavoring to escape the severity of the weather, which was unusual.

I wandered along a wooded hill-side having a southern outlook, and from thence to a narrow strip of marshy meadow beyond. An occasional meadow-lark, a single song-sparrow, and the grass-finch (*Poöcætes gramineus*), ever at home, were the only birds to be seen. After a three hours' ramble I turned my steps homeward. It was scarcely two hours before sunset, and while I lingered under the grand old oaks and listened to the occasional chirp of some unseen and distant sparrow, a loud, whirring sound and constant chirping caused me to look up. In the same oaks was another flock, but of very different birds. They, too, were recognized at a glance. They were the purple finch (*Carpodacus purpureus*). They lingered for many minutes, when with one accord, though I could not determine upon what signal, they, too, took flight, but in a westerly direction and in the face of a bitterly cold wind that was just freshening into a gale.

The particular actions of these two flocks of widely differing species of finches were of much interest to me, and have suggested some thoughts as to the purport of their evidently migratory movements.

It is not an unusual occurrence for any one species of our birds suddenly to quit a neighborhood where they may have been in

numbers for many weeks, and after a longer or shorter absence as suddenly to return to their accustomed haunts. More particularly is this the case with our winter residents. It is generally supposed that these semi-migratory movements are in consequence of meteorological conditions, the birds having the power to foretell a change by recognizing it through alterations in inanimate nature, not appreciable by man, or more probably by electric conditions acting directly upon them, on the same principle that a gouty big toe is an excellent barometer. Granting that these sudden departures from a given neighborhood by any species of birds or by the birds generally are caused by a meteorological influence, operating on each individual alike, would they not then go as individuals from the locality where the influence is felt to one better suited to them, during the prevalence of the obnoxious conditions? Every bird would then become a mere automaton, wafted to and fro at the mercy of the winds and clouds. While I do admit that the weather is the determining cause of the birds' movements, I am convinced that the influence is exerted in a somewhat different way. These temporary migrations are not made individually, but collectively, the birds maintaining a close association, their numbers not varying between the times of their departure and arrival. No meteorological influence could produce a flocking of any species, as represented in a given area, previous to forcing or at least inducing them to quit the neighborhood. Now, if we allow to birds exact geographical knowledge of a considerable extent of territory, then experience will have taught them, without doubt, that a ravine extending at right angles to the track of a storm is a proper shelter while the storm or "spell of severe weather" lasts; and the atmospheric conditions pending the change admonishing them, the scattered birds would depart thereto and arrive singly from every quarter, congregating for the first time when safely in the protecting ravine; but this is not found to be the case at all. They congregate wherever they may happen to be, and this necessitates an uttered signal, understood by them. Once collected they determine their route and depart in company. In December last, as I have related, I met with two such flocks of migrating birds. In thus associating they must derive either benefit or pleasure, if not both. If benefit, it must be that a mutual understanding exists among them; if pleasure, there must be an interchange of the impressions made upon one to the other. That it is an audible interchange we all know, for flocks of

mutes do not occur; that it is a varied expression of notes, peculiar to each species, is as well known; and so, judging these same birds from a human stand-point, they assuredly know themselves and understand each other, have definite expressions for certain conditions, have, in fact, the gift of language as the natural outcome of that power of thought which their methodical lives show they duly exercise.

The presence or absence of food in any given locality is also rightly supposed largely to influence the stay or departure of all birds, either resident or migratory; but let us take the instance of the roving purple finches I have referred to. In this case there was doubtless an abundance of food available for weeks in the little wood in which they tarried for so short a time. They certainly did not remain long enough to determine that point, and so gave evidence of a predetermined journey to some particular point, towards which they were moving when I chanced upon them. On these same oaks and about the hill-side generally, scores of times I have seen these finches often for days together, and consequently finding sufficient food. When I last saw them they were not seeking out better feeding grounds than those they had left, but a locality otherwise more suitable. If, then, there is in the character of these migratory movements even a trace of predetermination, does it not bear directly upon the question of the conveyance of impressions from one to the other? and if the sounds they utter are closely related to their movements, can we conceive of these as having any other significance than that of being the means by which they express their thoughts,—that their utterances are strictly a language? One can easily believe that an elaborate song is a pleasure to the little musician himself as well as all his hearers, and may be given, perhaps, with a wholly selfish intent; but not so can we explain away the endless chirps and twitters expressed during the ordinary routine of each day's existence.

Again, as bearing upon the subject of birds' flocking, together with their various "notes" or language, it is to be borne in mind that widely different species do not migrate together, but on the other hand, allied species and genera are thus associated, and there is a marked similarity in very many of the "calls" of these allied species, as well as identity in habits and preference for the same localities. And are not these facts, by the by, suggestive of the great probability that in the distant past the variations now existing in our widely different birds were far less in num-

ber, and that the influences exerted by endless external conditions have been in part the origin of the so-called species of to-day? But possibly speculation as to the origin of the specific variation in bird life is in vain; and coming back to the present, to see it as it is, we find far more that suggests laborious study than a life-time can accomplish; and that, too, without seeking for marked exhibitions of ingenuity on the part of the birds. Interesting as these are to the field naturalist, whenever met with, it is doubtful if such chance occurrences are really as instructive in one's endeavor to appreciate the mental endowments of birds as are their ordinary daily and seasonal acts.

And again, as indicative, I think, of the existence of a mind essentially the same as our own, is that love of company of their own kind, which is so marked a feature of bird life. Birds may be associated and influenced pleasantly by each other's presence without being "flocked," as we say of gregarious species. After nearly a score of years of out-door study in the woods and about the fields, through the marshes and over mountains, I am well satisfied that the bird is eminently a social creature. One need but watch the busy warblers as they wander from twig to twig of our elm-trees to note how humanly they act when two chance to meet face to face while passing around the large branches: a moment's halting, a cheery twitter, a still more emphatic adieu, perhaps their parting note, and they separate to continue their untiring search for insects.

Capture, if you have the heart to do so, a nest-building bird, and place it in a cage, near the site of its unfinished home. See with what painful curiosity its puzzled mate endeavors to comprehend the mishap, and fearless of the cage itself, with what close scrutiny it is examined, in hopes of finding some available crevice through which the captured bird may escape. Note with what care an abundance of food is brought to the prisoner, showing that the bird realizes some of the difficulties into which its mate has fallen. The utterances of both, too, are at this time worthy of the closest attention. They are not simply the sharp chirp of fear on the part of the captured bird, but a varied intonation, characteristically responded to by the bird at large; and one cannot fail to interpret it as an appeal for assistance. I have experimented in this cruel manner many times; and while the caged victim was confined, its mate proved faithful, and the character of every act under these peculiar circumstances, in connection with their utterances, confirmed my belief that their vocal

power has been evolved for the same ends and largely meets the same requirements that the power of language accomplishes for man.

Let us now view bird life from another stand-point. There are not a few indications to show that birds are not victims of predestination, such as some worthy people are unhappily deluded into supposing themselves to be, but, being quite free to choose, exercise not a little forethought, especially in spring, in predetermining their movements, in part, during the coming season. How else, for instance, can we explain such a fact as the abandonment of a partly constructed nest and rebuilding elsewhere, usually on the same tree? I have so closely watched orioles while building, that I am confident that a nest nearly finished was abandoned not from experience of its being of too easy access to enemies, but because subsequent thought suggested the possibility of such an occurrence, and therefore the change of position was decided upon. Such instances are quite common; and strangely enough these abandoned nests are not utilized in the manufacture of another, but are left, I believe, as a blind to the enemies, which now are happily but few, of this particular bird. In one case the delicate branches of a weeping-willow being found too slight for the weight of the nest when occupied, another branch some few inches distant — as nearly as I could determine, about a foot — was brought into use, as an additional support, by carefully interweaving a long string with the body of the nest, and then carrying it up and attaching it by a number of turns and a knot to the branch above. Thus secured, the nest sustained the weight of the young when fully grown and both the parent birds. The little warbling fly-catchers that build a semi-pensile nest in the fork of delicate twigs have been known to do precisely the same thing, especially when the cow-pen bird (*Molothrus pecoris*) burdens them with an egg that when hatched taxes severely the strength of their slightly built nest. Here we have forethought, for while the nest, in the case of the orioles, was sufficiently secure for the proper care of the eggs, and would sustain the additional weight of one bird, they knew that when the young were well grown and required the care of both parents in feeding them, then the nest must needs be stronger than they had originally made it. Can we consider it probable that the same idea of future insecurity occurred to both parent birds simultaneously? Yet they worked together in the addition made to it. Rather the idea, occurring to one, was com-

municated to the other, and the chirps and twitters of a whole afternoon were their sole means of communication. Here, have we not, without overstraining our imagination or at all taxing our credulity, a veritable glimpse of mind in birds? Further, is it not an indication of a high order of mental power? These birds were not simply pursuing the ordinary routine of nest-building, but actually carefully considered the future and its possible mishaps, and guarded intelligently against them.

The senseless persecution to which our common crow has been subjected by short-sighted farmers — for it is in reality a most valuable bird to the agriculturist — has rendered it exceedingly shy and cunning. This is well known to every one who has ever seen a crow, at least in our Middle States. While timidity has doubtless become hereditary in all our birds, and is increased in every individual through imitation of the parent birds, which themselves act not only from hereditary impulses, but from experience, on the other hand cunning is not necessarily an inherited trait, as it differs so greatly in individuals, but is an acquired one; and can we be mistaken in considering that this same cunning on the part of some is recognized by the masses, and being constantly associated, they naturally learn to defer to the better judgment of the superior birds. On the other hand, crows, as men, soon learn to realize their superiority over their fellows, if they possess any, and quickly assume the position of leaders. In some very similar way, I believe that crows have developed through their experience as persecuted creatures that power of organization — executive ability we call it in mankind — through which they are able to maintain their numbers and escape destruction. It may be urged that superior cunning ought likewise to have been evolved among our game birds, inasmuch as they have been far more persecuted, so that they too might have successfully baffled their tormentors and maintained their ground. I can but say that to some extent it probably has, but that they may have less active intellects, and their being so unintermittingly pursued has had a depressing effect; while on the part of crows, persecution has resulted in acceleration of the development of mental powers. Contact with man, it is easily seen, has sharpened the wits of many of the lower animals, to such an extent in some, that like the crow they can resist him; while others, like the great auk, perhaps through want of energy, have perished.

Birds are not naturally given to excesses in eating or drink-

ing, but now and then it happens among the berry and seed-eating species that they do not discriminate between wholesome and unhealthy food, and the result, very naturally, is sickness. I have known robins to be poisoned by eating belladonna berries, and sparrows to become "bewildered" by pecking at trash thrown from an apple-whisky distillery. These occurrences suggested a simple experiment with alcohol, and my victims were crows. While the ground was well covered with snow and the crows quite tame in consequence of the scarcity of food, I soaked some corn with alcohol and placed it where the birds readily found it. In a few minutes it was all devoured by four crows who, like Oliver Twist, were clamorous for more; but their clamor soon ceased. The ordinary intoxicating effects of alcohol soon began to show themselves, and stranger antics no silly parrot ever yet performed. They gave way at first to loud and rapid talking, loud even for a crow; then, after vain endeavors to fly away and subsequent ones to rest upon the topmost rail of a neighboring fence, they gave themselves up to the most ludicrous, subdued mutterings, and finally turned gracefully over, fell from the fence, and lying in uneasy positions upon the snow soon became entirely motionless, as profound slumber overcame them. The facts I desired I believe were obtained. The physiological effects of the alcohol proved to be the same as in man; and I am convinced that we have an indication here of what is in all probability the case, that their brains are at least so far like our own that the normal operations of the organ are, too, of identical character. Crows see with their eyes, they hear with their ears, and why deny that also they talk with their tongues and throats, and think with their brains? When we realize the full extent of the mental capabilities of birds, the mighty distance that ignorance has imagined lies between the brute creation and mankind becomes narrowed to a little space indeed. So, when we study mankind precisely as he is, and recall the semi-brutal state of prehistoric times, it is doing no violence to truth to see more of humanity in the less favored forms of life, and to admit that our own progress is still clogged by the traces of our former brute-like condition. Allied to the subject of intoxication is that of permanent insanity. Does a functional or organic disease of the brain ever occur in birds? Of course all reference is to birds in a state of nature. We are all familiar with instances of birds in confinement that have apparently died of grief from the loss of their mates. We have here a case of cerebral action

that cannot be explained, if to a bird's brain we only accord the operations of instinct. Grief has no more to do with instinct, pure and simple, than ordinary emotions have to do with the heart; and yet birds certainly do experience all the pains occasioned by grief, and when this becomes excessive, so as to cause death, then it has at least reached the border lands of insanity. I now ask, Do birds ever in their feral state pass quite beyond it? If not wrong in considering intoxication temporary insanity, then certainly birds are at times permanently insane.

It not unfrequently happens that birds are forced to take flight at night, when darkness only is visible, and are wounded or stunned by coming in violent contact with some resisting object. While such an accident usually proves fatal, it not always does so, although permanent cerebral injuries are received. I recall now an instance of a male quail coming with tremendous velocity against a window, literally cutting a passage for itself through the pane, and falling on the floor on the opposite side of the room. The bird was picked up for dead; but while being examined it revived, and the ill effects of the concussion partially passed away; but assuming that the bird was as mentally strong as its fellows before the accident, it was ever after not subject to occasional fits, as a cause of the mishap, but in fact permanently insane. While none of its movements were what one might expect of a quail in confinement, this one had a number of very crazy notions. The most noticeable peculiarity was that of whistling its ordinary call-note backwards, thus, "*White′*-bob," for Bob-*white′*. The intonation and accent were exactly reversed, and were at once noticed by every one who had ever heard a quail whistle. While very tame and gentle with the family, it readily recognized strangers as such, and if approached by them would strike at them with its claws, lying flat on its back, reminding one forcibly of a wounded hawk. Another very marked peculiarity of habit was that of chasing or appearing to chase its food, the bird evidently laboring under the impression that its food was alive and endeavoring to escape. It may be claimed that the passage through the pane of glass may have injured its eyesight, and so the apparent chase of its food was caused by disordered vision. This is met by the fact that in no other way did its vision appear to be affected, and it was tested in several ways; and again, the effects of the concussion would scarcely have caused also an alteration of its vocal organs, as though its larynx by the blow had been turned wrong end foremost.

Somewhat similar instances have occurred, where birds have been slightly wounded with fine shot. The wounds have entirely healed, the locomotive powers are all restored, and yet the bird is quite another creature, not only in its manner in confinement, but its desire for liberty, so strong in birds, has totally disappeared. The effects of the wounds have been to radically change the mental characteristics; yet, so far as determinable, every function of the body is in proper working order. If, then, it is unnatural in its ways, endeavoring to do many things to which it is not adapted, and which its wild associates never do, it is simply insane; and if insane, then there must be the essential elements of a mind, to become either wholly or in part deranged.

Setting aside these extreme cases of wounded birds, and looking closely at birds at large, we will find a vast difference in the relative vivacity and agility of our feathered friends. This difference, of itself, is interesting; but become familiar through gentleness with the robins and cat-birds that are building their nests near your homes, and make the acquaintance of the bluebirds, sparrows, and wrens, and every creature of the avi-fauna of your neighborhood, and you will surely find among them, here and there, some melancholy individual that has no home, if we limit birds' homes to their nests, and certainly with no visible means of support, if it depends upon its mate to take care of him or her, as the case may be. These birds, unmated, moping, and almost voiceless, are, to say the least, eccentric. One instance in particular is vividly recalled, that of a meadow-lark (*Sturnella magna*) which for hours would sit upon a certain limb of a dead tree, and only leave it voluntarily for a short time to feed. It never sang, and when on the ground did not associate with its kind, but trotted about with chipping sparrows, along the garden fence. Its one peculiarity, marked above all others, was the resentment with which it met the advances of its fellows. If one perchanced to alight on this crazy lark's adopted home, it would be vigorously attacked, and the intruder invariably was driven off. At such a time it would utter a vigorous chirp, but at no other time did I hear any note uttered. It remained thus, in the one limited spot, for three weeks, and was then found lying dead at the foot of the tree. Dissection showed no peculiarity in the anatomy of its brain or viscera, and there was no indication that it died either of grief or starvation. I believe it simply a case of insanity. Another such case was that of a cat-bird.

This poor fellow for the greater part of one summer haunted a row of currant bushes, in a very melancholy mood the while, and when seen by other cat-birds, they would immediately give it chase. The persecuted bird was readily recognized by having a single snow-white feather in its tail, which was otherwise of normal size and color. It is not to be supposed that albinism which extended only to one feather could have been the cause of this ostracism, and we refer the cause to the mental state of the bird, and that being recognized as weaker and perhaps otherwise unnatural, they would have killed it had it not been able to escape their attacks by taking refuge in dense foliage close to the ground. Its movements indicated physical health, its loneliness and inability — shall we say? — to please its fellows, indicated mental ill health, that is, insanity.

It is scarcely necessary, and space forbids our going further into details in the elaboration of such phases of bird life as, to human comprehension, are apparently identical with the allied acts in man; and, indeed, if it can be shown that under any one circumstance a bird thinks, it as satisfactorily determines that the creature has a thought-producing brain, as though we trace his mental powers from the nest to the close of adult life. Have we not more than one such circumstance here narrated, as a "proof that birds possess a faculty indistinguishable, so far as it goes, from human reason"? When noting the circumstances of limited migrations, we saw that it was not a blind movement on the part of each individual, but the influence being alike recognized by all, they congregated and departed with a full knowledge of whither they were going, this predetermination being shown by the character of their movements while journeying. The validity of the opinion that birds fully comprehend and attach definite meanings to their range of utterances we endeavored to show in the flocking of allied species and genera, instead of the promiscuous assembling of birds of widely differing types. Their love of company was pointed out as bearing, too, upon the subject of language as man understands it, being also an attribute of birds, this association extending beyond the duration of nidification, and not limited to single pairs, but the individuals of each species residing in considerable areas. This love of the company of their own kind is not a mute association, but marked by an extensive range of vocal powers other than their songs proper, which bear the relation to language that singing does to conversation in ourselves, and bear every indi-

cation of being expressed for the purpose of conveying to others thought on the part of the utterer. When birds are nest-building I have shown that the subject of future requirements is duly considered, when *the thought* occurs to the busy birds, and is acted upon by both, after its necessary communication by one to the other, in an intelligent manner, thereby demonstrating a cerebral action identical with that of man when analogously circumstanced. I have endeavored to show that cunning on the part of crows was largely acquired, and differed in individuals, showing a variation in brain power, and also that their association was too well organized to be looked upon as other than one where there were some superior intellects to guard the interests of their masses. Finally, we have seen that the ordinary physiological effects of alcohol, such as obtain in man, render birds liable to drunkenness when they unwittingly indulge too freely; and just as their brains, as do human brains, respond to its effects, so there is also abundance of reason for believing that insanity, too, may arise from just such causes as produce this malady in man.

Thus, rapidly glancing over the range of bird-life, in its feral state and in confinement, in health and in disease, we may see that much that is often thought peculiar to mankind is partially, also, an attribute of birds. We must, if disposed to see all animate nature with unbiassed minds, grant to these lower forms a higher grade of intelligence; and if, as yet, we cannot bridge the chasm that separates us from them, it is not so much that the chasm is too broad as that our pride and ignorance vainly supposes it to be wider than it is.

THE AGE OF THIS EARTH.

BY H. P. MALET.

AN able article in the *Quarterly Review* for July, 1876, gives the calculations of several sciences, differing from one another by tens and hundreds of millions of years, on the age of our cosmical system.

Physical geography was not represented; we claim for it not only as great a knowledge of facts in reference to the main point as any other science possesses, but the means of enabling us to point out where other sciences seem to be in error as to time, to data, and consequently in their complex calculations.

Mathematicians are so correct in their figures that when they start from one point to reach one end, their ends ought to be the same; when these ends vary and we find no fault in the calculation, we must look into the data for the cause of variation and error.

The article alluded to gives us an outline of cosmical beginnings from the theory of Laplace, published in 1796 (Maunder). Astronomers had been aware that many nebulæ floated in space; these became "specimens of worlds in making," under the powerful telescope of the French astronomer. As the nebulæ became denser, they came under "the action of gravity;" consequently "a succession of rings, concentric with and revolving round the centre of gravity," were formed. "Each ring would break up into masses, which would be endued with motions of rotation, and would in consequence assume a spheroidal form. These masses formed the planets, and gathering with energy round its centre formed the sun." It is then explained "that the earth could not have had an independent existence till long after that time . . . for before then the earth must have formed part of the fiery mass of the sun;" the *Quarterly* observing, "Thus, probably, was the world we live in and the solar system of which we form a part evolved out of chaos."

Science has proved that motion causes heat, and therefore the sun was provided with a supply by the action of the nebulæ. If they were cold when they came together, — the only condition they could have been in, — the supply of heat was calculated to last for 20,250,000 years at the present rate of consumption. Thus "the dynamical theory of the sun's heat renders it almost impossible that the earth's surface has been illuminated by the sun's rays many times ten millions of years; and when we consider underground temperature, we find ourselves driven to the conclusion that the existing state of things on the earth, life on the earth, and all geological history showing continuity of life must be limited within some such period of time as 100,000,000 years." This authority, Sir William Thomson, is reported to have told the British Association at Glasgow that "50,000,000 years is an even estimate" for the age of this earth.[1]

A comfortable margin of fifty per cent. seems convenient to the precise sciences. Professor Tait is reported to have said in a late lecture at Glasgow, in alluding to differences on this subject, "So much the worse for geology as at present understood by its

[1] The Mail, September 8, 1876.

chief authorities, for physical considerations render it impossible that more than 10,000,000 or 15,000,000 of years can be granted." Before entering on physical details it will be as well to point out a curious question between mathematicians and geologists in reference to "under-ground temperature." Some geologists assign all igneous action on this earth to local chemical causes; but the fashionable school allows its ignorance on this subject in the Text-Book of Geology, by Mr. Page, seventh edition, page 51: "The occurrence of volcanoes, earthquakes, escapes of heated vapors, and thermal springs are by far too numerous and general to be accounted for on any principle of chemical union with which we are acquainted." In other words, the expenditure of heat from the earth is supposed to be more than local chemical causes could supply. Mathematicians give "20,250,000" years of heat to the sun; as this earth is supposed to have been an offshoot from its "fiery mass," we may infer that when the earth was detached it must have been in the same hot condition as the parent mass. Mr. Proctor gives us the diameter of the sun at 850,000 miles, and Guyot's geography gives the diameter of this earth at eight thousand miles. If, then, the diameter of the sun contains heat for 20,250,000 years, the diameter of this earth can hold heat only for 190,588 years. We know nothing of fresh supplies of fuel to earth or sun, in reference to the theory of Laplace; we give the sun the credit for greater expenditure of heat than the earth; but if geologists are right in supposing that local chemical causes have been unequal to the earth's expenditure, and that this has been going on for ten, twelve, fifty, or one hundred millions of years, according to the calculations of physical science, we may wonder why the internal fire did not become bankrupt long ago. We may also remark, in passing, that if igneous action is of any advantage to this earth, it is lucky that neither science had any hand in its origin.

It was pointed out by the German metaphysician, Kant, and has been accepted by others, that there has been a retardation of the earth's revolution from the tidal wave. The conclusion, as given in the *Quarterly*, is, "She was rotating at about the same rapidity as now when she became solid, and as the rate of rotation is certainly diminishing, the epoch of consolidation cannot be more than ten or twelve millions of years." This calculation cannot be of much consequence to the cosmical system; but as no one knows how the tidal wave acted before there was land for it to flow and ebb upon, we put the theory down as useless,

and accept the tidal action as a part of the dynamical action, that helps to keep the whole sphere in equilibrium.

We now come to a mixture of mathematics and geology. The late Sir Charles Lyell, calculating from the present growth of the dry land, put the age of this earth at 300,000,000 years, the fossiliferous strata at 240,000,000, and the Glacial epoch at 1,000,000 years ago.

The earnest and accurate mathematician, Croll, endeavors to modify the geological epochs by a calculation "at once beneficial, simple, and complete. . . . The land has been many times under the sea, and the most violent changes of climate have succeeded one another." Causes are produced to show "that every ten thousand years, or thereabouts, the winter of the northern hemisphere will occur, . . . whenever any records are left of the Glacial epoch, a general subsidence of the land followed closely on the appearance of the ice, . . . the extent of submergence will be in proportion to the weight of ice, . . . glaciation would be transferred from one hemisphere to another every ten thousand years. There would be elevation of the land during the warm period, and subsidence during the cold."

The article goes on to tell us that "the discovery of Mr. Croll upsets the whole scale of geological time." Croll gives four periods of glaciation, the last of which was 200,000 years ago; so that the Glacial period is reduced to that age, the date of the fossiliferous rocks to 48,000,000, and the age of the earth to 60,000,000 of years.

All glacial epochs are supposed to have left their marks behind them. Croll says they occur every ten thousand years, but the writer of the article has left out twenty of these periods, and selected one of Mr. Croll's without knowing whether Sir Charles Lyell referred to that particular period or to another which Croll tells us took place 850,000 years ago. As figures go in this matter, Sir Charles would have a very small margin of 150,000 years if he worked on the traces of this period. The writer of the article seems to have had an object in his figures by reducing them as nearly as possible to his own.

We must now consider two more facts brought forward by Croll in support of his calculations: —

First: "The land has been many times under the sea." . . . "The submergence will be in proportion to the weight of ice." The latter quotation cannot be proved; ice vanishes, and its weight cannot be known. Submergence of land takes place all

round the world. The causes are soft foundations and growing superstructures, pressures, sinkings below water, sedimental gatherings, gradual risings, and the repetition of the same actions till a solid foundation is secured. When foundations are undermined by subterranean water action, submergences of surface areas occur suddenly, and the rising again is uncertain.

Second: "Violent changes of climate have succeeded one another." Opinions vary as to the cause of this in the arctic regions. Some follow Mr. Croll in his see-saw theory, or the oscillation of the poles. If it takes place, changes of climate must ensue; but a very material point seems to have been forgotten, — if the oscillation is cosmical the water would go down with the land, there would be no submergence. There would be ten thousand years of ice and ten thousand years of warmer climate. These changes would be general, but the fossils of warmer regions do not prove a general growth, neither do the warm-region drifts of the present prove a general action through the arctic regions. In the late arctic expedition it was colder on one shore of Smith Sound than on the other; and Captain Sir George Nares gave this experience of the Arctic and Atlantic Oceans to the Royal Geographical Society.

In the Atlantic Ocean there is "an enormous reservoir of heat." This warm water is forced "gradually towards the northward and eastward, modifying the climate of all parts lying in its course. There is also a warm current ever running to the northward through Behring's Straits." These warm supplies run at present through certain channels, while in other channels "an icy cold current" runs to the southward. The polar basin has a "warm stream of water constantly pouring into it between Spitzbergen and Norway, and a cold icy one as constantly running out between Spitzbergen and Greenland, also . . . between Greenland and America; . . . so great is the difference of climate caused by these powerful distributors of heat and cold that the temperature of the sea . . . twenty-two hundred miles from the equator is precisely the same as that nearly double the distance from the equator."

As we have these cosmical actions, guided by fixed cosmical laws, perpetually circulating the heat and the cold, — not always in the same channels, but distributing both according to the direction of either current, — we find a certain cause for the "violent changes of climate" alluded to, instead of the more than uncertain oscillation with the doubtful results of Mr. Croll. We

cannot agree with the author of the article in the *Quarterly*, or allow that this Glacial theory in any way interferes with geological time as laid down by the late Sir Charles Lyell. Having thus disposed of certain details as to the age of this earth, we must now briefly consider the position of our geological science on this point.

Properly speaking, geology is a discourse of things on or in the earth, of things tangible and visible. Geologists in accepting the theory of Laplace, make the foundation of their science neither tangible nor visible. It suited geology to adopt it because, in the prevailing ignorance of natural laws, it seemed to explain the causes of certain phenomena. Now that a more accurate knowledge of cosmical law is creeping up, there is no excuse for adhering longer to a theory which is incapable of explaining the cause of igneous phenomena on or in the earth, while it is made ridiculous by the little figures of the mathematicians.

We cannot meet the dogmas of science on this subject because we think with a finite mind on an infinite beginning; but we ask geologists and mathematicians to follow us through a brief tracing of the cosmical laws and their actions from that beginning, as far as that has been revealed to us till now.

There was a void chaos of waters without form, and dark; how long this earth remained in this condition we do not know. A water-bed was formed, light was given, motion, day and night ensued, revolution of the earth on its axis had commenced and continued to this sphere its hours of labor and of rest. Another result followed the presence of light: water was attracted by it, as it is to-day; the water clouds were collected in the firmament, and were divided from the waters under the firmament; all this law is in force now, but no one can say how long a time elapsed before the action became perfect and complete.

As the light caused a movement in the waters, so the waters acted on their bed. No one can say where the general level of that early bed was. But as it deepened from the ever-acting erosion of the waters, they were of necessity gathered unto one place, and the bed which they had rested on became dry land.

No science can tell when this happened; we do not know where the first water-level was, the level of the dry land or its locality; no one knows when light first shone upon earth, or when it first divided the waters; we cannot say how long the atmosphere and the water were occupied in forming the silicious nucleus of our earth, but we know that it gives silicious matter

now. We cannot tell when the water was separated from the atmosphere, or how long the atmosphere retained in itself the elemental constituents of water and of earth. The mathematician and geologist have nothing to do with the subject before this event took place; there is nothing visible or tangible, no data for a single figure. The moment dry land is created the physical geographer begins his labors. They are not difficult; he knows the uncertain forces that work under cosmical laws on forever changing materials; by knowing the results at present, he can tell those of the past. Far be it from us to suggest infallible action; we can but give a faint outline of the whole, but we give nothing that cannot be verified by the law and its actions at the present moment.

The geographer looks through time upon the face of the first dry land; he sees the water-sheds giving out their little trickles all running down the slopes, all wearing away something in their course, all depositing some atoms on their way, and all carrying on to their little estuaries or deltas a constant succession of minute atoms. He sees the deltas constantly extending by the addition of atoms, and constantly rising in consequence of the retiring of the waters. He sees constant additions to the dry land made by the water in one place, and constant abstractions in another; he knows that every atom taken from the water-bed makes that bed deeper, and every atom taken from dry land helps eventually to extend its shores.

Under these actions he comprehends that the dry land must have gone on growing, and that the undulating ocean bed must have grown deeper where its currents ran, and shallower where they did not; he traces the gradual growth of these shallow places, not by any forcible elevation of the mass, but by the slow departure of the water, by the sediments left upon them, by the eventual growth of vegetation, by the creation of life, by the elemental forces forever returning to their dusts, in some regions or another, to the extending deltas and the growing dry land.

He looks upon the mud and sand-banks of to-day and sees the same forces at work under the same laws; he knows that these forces acted under the same laws at the beginning, and he knows that they acted on the materials then available as they act on the materials of to-day. He marks through legends, history, and his own experience the denudations and the additions of the seashores; he finds that in thousands of years the general contour of the dry land has remained the same; he finds that localities have

been added to and taken away. In these subtractions he sees the fossil remains of prehistoric organic structure torn from their resting-places in the calcareous rocks, he handles the flint nodule formed from the silicious dusts of diatoms and foraminifera, and finds the same dusts in course of deposit in the deepest parts of the ocean, telling him, not only that these organisms have continued their races for millions of years, but that they have, for all those ages, left their dusts to subside upon the ocean bed, certain evidence that the site on which we find the stratified calcareous rocks, with their lines of flint nodules, was once the ocean bed. He may look on the sand collections now on our surf-beaten shores, on the wind-drifts of the great deserts, and on the sand-dunes in many regions; he does not know when they began to grow, but he sees on mountain sides sandstone rocks several hundred feet in thickness, many miles in length and breadth. He knows that they were formed and gathered by the same forces that now occupy hundreds of years in adding a few inches to the shores, and he is lost in thinking of the vast amount of silicious matter broken up, triturated into sand, and deposited by the water on its bed, and that bed hundreds of feet above his head. He finds the hard silicious rock in stratified form on the tops of our highest mountains, in their interior, and in the deepest seas, where it still wears away and contributes atoms for deposit in other places. He is lost in the time occupied by the deepening of the sea, by the vastness of the deposits formed by it, far above its present surface level, and by the extent of deposit now in progress in its depths. The geographer knows that every river is always bringing something to its estuary, yet its growth of dry land is very slow; he measures it, but he cannot tell by that measurement when the estuary of the Nile was four thousand miles from its present site. He may trace the Mississippi from its present watery delta back to its tributaries in the Rocky Mountains, but it does not tell him when these, now great, waters trickled as little rills from the first dry land of those regions. He looks upon the water-worn chasms of the Himalayas and the Alps, on the vast gorges of great rivers; he cannot say when those rivers began to run, or how long it took them to wear away the hard obstruction to their course, any easier than Sir Charles Lyell could tell the age of the Niagara Gorge.

He may see the vast structure of the coral insect [*sic*] now growing over thousands of miles in the Red Sea, but he does not know when those structures were commenced. He sees the stu-

pendous mass of the dolomite mountains: he knows that these were all lodged as sedimental matter where they now stand by the same water forces which had previously built up the silicious Alps; that all the materials of which they are formed were brought atom by atom, just as atoms are lodged on our sea-coasts to-day, by the waters, which were then deeper than the mountains are high, from places on the sea-bed which were shallower, places that were washed away, and deepened by the very force that broke up the coral banks, carried them away, and lodged them where they are. He can form no idea where or when the insects lived that gathered all this calcareous matter from their water, how long it occupied them in constructing their palaces, how long they existed, when they were pulled to pieces, how long they were triturated by current and by wave, or when the atoms were permitted to become deposits.

He may look on the calcareous matter of the Jura Mountains and know that they are formed from bones and shells of a fauna that once lived on land or in the water; he knows that these masses were lodged in water as deep as the mountains are high, in minute fragments, with an occasional entire shell or an unbroken bone, but he knows nothing of the land or water in or on which the fauna lived. He cannot count the time occupied in the formation of these mountains, or tell for how many ages the fauna lived that left their dusts to form them. Wherever the physical geographer turns he is lost in the lapse of ages. The waters have left their old beds, the land has acquired new dimensions. All dry lands have their high places, from which their water-sheds convey their atoms away; every atom helps to extend dry land; the water-sheds are the agents for the work, and the great waters are the agents for the separation of matter, and for its deposit in its proper place. All this is done now under certain laws by the cosmical agents, air and water.

No one knows better than the physical geographer the truth of the words used by the writer in the *Quarterly Review:* "In all the operations of nature . . . God worked by law, . . . by the process of slow development, by means beautifully simple, involving no violence, no haste, yet irresistible." No one sees more clearly the error, ascribed to Professor P. G. Tait, in *The Mail*, 8th January, 1877: "The present state of things has not been evolved through infinite past time by the agency of laws now at work, but must have had a distinct beginning." "When was it, and what was it?"

It is the slow, the certain, the beautiful, and the unchanging process of cosmical law, which gives the character of infinite to the universe. Finite man has not as yet read the pages of the law, and cannot therefore calculate the age of this earth. He has tried over and over again to do so, but Professor Tait is not so near to the truth as Solomon was; other "guesses" (*Quarterly*) may be nearer, but the men who guess are at present without chart, compass, or sounding-line on the fathomless and boundless ocean of eternity. — *The Geographical Magazine.*

EVOLUTION IN THE NETHERLANDS: TESTIMONIAL TO MR. DARWIN.[1]

WE have great pleasure in printing the following correspondence: —

UTRECHT, *February* 20, 1877.

TO THE EDITOR OF NATURE, — On the sixty-ninth birthday of your great countryman, Mr. Charles Darwin, an album with two hundred and seventeen photographs of his admirers in the Netherlands, among whom are eighty-one doctors and twenty-one university professors, was presented to him. To the album was joined a letter, of which you will find a copy here inclosed, with the answer of Mr. Darwin.

I suppose you will like to give to both letters a place in your very estimable journal, and therefore I have the honor to forward them to you.

P. HARTING,
Professor, University, Utrecht.

ROTTERDAM, *February* 6, 1877.

SIR, — In the early part of the present century there resided in Amsterdam a physician, Dr. J. E. Doornik, who, in 1816, took his departure for Java, and passed the remainder of his life for the greater part in India. His name, though little known elsewhere than in the Netherlands, yet well deserves to be held in remembrance, since he occupies an honorable place among the pioneers of the theory of development. Among his numerous publications on natural philosophy, with a view to this, are worthy of mention his "Wijsgeerig-natuurkundig onderzoek aangaande den vorspronkelijken mensch en de vorspronkelijke stammen van deszelfs geslacht" (Philosophic Researches concerning Original Man and the Origin of his Species), and his treatise,

[1] From Nature, London.

"Over het begrip van levenskracht uit een geologisch oogpunt beschouwd" (On the Idea of Vitality considered from a Geological Point of View). The first appeared in 1808; the latter, though written about the same time, was published in 1816, together with other papers more or less similar in tendency, under the title of "Wijsgeerig-natuurkundige verhandelingen" (Treatises on the Philosophy of Natural History). In these publications we recognize Doornik as a decided advocate of the theory that the various modifications in which life was revealed in consecutive times originated each from the other. He already occupies the point of vantage on which, shortly afterwards, Lamarck, with reference to the animal kingdom, and, in his wake, Prévost and Lyell, with respect to the geological history of our globe, have taken their stand.

Yet the seeds scattered by Dr. Doornik did not take root in fertile soil. It is true that a Groningen professor, G. Bakker, combated at great length some of his arguments regarding the origin of man; they attracted but little public attention, and soon passed into oblivion.

A generation had passed away ere the theory of evolution began to attract more attention in the Netherlands. The impulse was given by the appearance of the well-known work, Vestiges of the Natural History of Creation, of which a Dutch translation was published in 1849 by Dr. T. H. van den Broek, professor of chemistry at the military medical college in Utrecht, with an introductory preface by the celebrated chemist, Prof. G. T. Mulder, as well known in England as elsewhere. This work excited a lively controversy, but its opponents were more numerous than its partisans. Remarkably enough, it found more favor with the general public, and especially with some theologians of liberal principles, than with the representatives of the natural sciences. The majority of zoölogists and botanists of any celebrity in the Netherlands looked upon the writer's opinions as a chimera, and speculated on the weaker points rather than on the merits of the work. Notwithstanding, this presented no obstacle to a comparative success, and in 1854 even a third edition of the translation was published, enriched by the translator with numerous annotations.

Among the few Dutch *savants* to recognize the light which the theory of development spreads over creation must be mentioned two Utrecht professors, namely, F. C. Donders and P. Harting. The former, in his inaugural address pronounced in 1848, "De

Harmonie van het dierlijk leven, de Openbaring van Wetten" (The Harmony of Animal Life, the Revelation of Laws), expressed his opinion that in the gradual change of form consequent upon change of circumstances, may lie the cause of the origin of differences which we are now wont to designate as specific. The latter, in the winter of 1856, delivered a series of lectures, before a mixed audience, on The History of Creation, which he published the following year under the title of "Voorwereldlijke Scheppingen" (Antemundane Creations), with a diffuse supplement devoted to a critical consideration of the theory of development. Though herein he came to a stand-still with a "non liquet," yet it cannot be denied that there gleamed through it his prepossession in favor of a theory which several years later his famed and learned colleague, J. van der Hoeven, professor at Leyden, making a well-known French writer's words his own, was accustomed to signalize as an explanation, "De l'inconnu par l'impossible."

In 1858 your illustrious countryman, Sir Charles Lyell, was staying for a few days in Utrecht. In the course of conversations with this distinguished *savant* on the theory of development, for which Lyell himself, at least in his writings, had shown himself no pleader, the learned of this country were first made observant of what had been and what was being done in that direction in England. He attracted attention to the treatise of Wallace in the *Journal of the Linnæan Society*, and related how his friend Darwin had been occupied for years in an earnest study of this subject, and that ere long a work would appear from his pen, which, in his opinion, would make a considerable impression. From these conversations it was evident that Lyell himself was wavering. In the following edition of his Principles of Geology, he declared himself, as we know, a partisan of the hypothesis of development, and Professor Harting speedily followed in the same track. In his "Algemeene Dierkunde" (General Zoölogy), published in 1862, he was able to declare himself with full conviction a partisan of this hypothesis. Also another famous *savant*, Miquel, professor of botany at Utrecht, who had previously declared himself an opponent of the theory of development, became a convert to it in his later years, for although this is not expressed in his published writings, it was clearly manifest in his private conversation and in his lectures. To what must this conversion be attributed? With Harting and Miquel, as well as with Lyell and so many others in every country of Europe, this was the fruit produced by the study of your Origin of

Species, published in 1859, which first furnished one vast basis for the theory of development. That work, translated into Dutch by Dr. F. C. Winkler, now conservator of the geological, mineralogical, and palæontological collections in "Teyler's Foundation" at Haarlem, excited great and general interest. It is true that a theory striking so keenly and so deep at the roots of existing opinions and prejudices could not be expected at once to meet with general approbation. Many even amongst naturalists offered vehement opposition. Prof. J. van der Hoeven, bred up as he was in the school of Cuvier, endeavored to administer an antidote for what he regarded as a baneful poison by translating into our tongue Hopkins' well-known article in *Fraser's Magazine*. However, neither this production nor the professor's influence over his students could withstand the current, especially when, after his death, the German zoölogist, Prof. Emil Selenka, now professor of zoölogy at Erlangen, was appointed at Leyden. A decided advocate of your theory, he awakened in the younger zoölogists a lively enthusiasm, and founded a school in which the conviction survives that the theory of development is the key to the explanation of the history of creation.

In Utrecht, Professor Harting, with convictions more and more decided, was busy in the same direction; and Selenka's successor in Leyden, Prof. C. K. Hoffmann, did not remain in the rear. Other names, among which are Groningen and Amsterdam professors, might here be cited. By the translation of your "Descent of Man" and "The Expressions of the Emotions in Man and Animals," with copious explanatory notes, and by various original papers and translations treating on your theory, Dr. Hartogh Heys van Zouteveen has also largely contributed to the more general spread of your opinions in the Netherlands.

To testify how generally they are held in esteem among the younger zoölogists and botanists, and more and more obtain among professors of analogous branches in this country, we might refer to a multitude of less important papers and articles in the periodicals.

This, however, we deem superfluous, since by offering for your acceptance an album, containing the portraits of a number of professional and amateur naturalists in the Netherlands, we offer a convincing proof of our estimation of your indefatigable endeavors in the promotion of science and our admiration of you, sir, as the cynosure in this untrodden path. We recognize with pleasure Dr. Hartogh Heys van Zouteveen as the primary mover

of such a demonstration of our homage. The execution, however, devolved upon the directors of the "Netherland Zoölogical Society," who reasoned that, with the presentation of this unpretending mark of esteem, a few words on the history of the theory of development in the Netherlands would not be entirely unacceptable, the more so, since this historic sketch clearly shows that, albeit some ideas in that direction had already been suggested here, yet to you alone reverts the honor of having formed by your writings a school of zealous and convinced partisans of the theory of development.

Among the names in the accompanying list you will observe several professors of natural history, anatomy, and physiology at the three Dutch universities, the "Athenæum Illustre" of Amsterdam, and the Polytechnical Academy of Delft, the conservators of the zoölogical museums, the directors of the zoölogical gardens, and several lecturers on zoölogy and botany at the high burghal schools.

Accept, then, sir, on your sixty-ninth birthday, this testimony of regard and esteem, not for any value it can have for you, but as a proof, which we are persuaded cannot but afford you some satisfaction, that the seeds by you so liberally strewn have also fallen on fertile soil in the Netherlands. We are, sir, etc., the directors of the Netherlands Zoölogical Society,

(Signed) President, A. A. VAN BEMMELEN,
Secretary, H. T. VETH.

The following is Mr. Darwin's reply: —

DOWN, BECKENHAM, *February* 12.

SIR, — I received yesterday the magnificent present of the album, together with your letter. I hope that you will endeavor to find some means to express to the two hundred and seventeen distinguished observers and lovers of natural science who have sent me their photographs, my gratitude for their extreme kindness. I feel deeply gratified by this gift, and I do not think that any testimonial more honorable to me could have been imagined. I am well aware that my books could never have been written, and would not have made any impression on the public mind, had not an immense amount of material been collected by a long series of admirable observers, and it is to them that honor is chiefly due.

I suppose that every worker at science occasionally feels depressed, and doubts whether what he has published has been worth the labor which it has cost him; but for the remaining

years of my life, whenever I want cheering, I will look at the portraits of my distinguished co-workers in the field of science, and remember their generous sympathy. When I die the album will be a most precious bequest to my children. I must further express my obligation for the very interesting history contained in your letter of the progress of opinion in the Netherlands, with respect to evolution, the whole of which is quite new to me. I must again thank all my kind friends from my heart for their ever-memorable testimonial, and I remain, sir, your obliged and grateful servant, (Signed) CHARLES R. DARWIN.

RECENT LITERATURE.

MIVART'S LESSONS FROM NATURE.[1] — Any one who expects to find in this book a series of mild and temperate homilies on the lessons to be derived from a study of nature will be disappointed. There is rather more said about the works of certain of Professor Mivart's fellow naturalists and philosophers than of the works of nature, and the book is more polemical than prosy. Herbert Spencer and Professor Huxley are criticised, often with good effect, and their weak points — for they have them — exposed. But the author in his criticisms of the agnostic school of philosophers is a little one-sided. In the present state of philosophy and science, the attitude of nescience may be a healthy and natural one. The author, while in his anatomical workshop using the tools of the agnostic, seems when wearing his philosopher's spectacles to look at creation in quite a different mood. In his fears of the ultimate prevalence of a purely scientific mode of thinking, he does not take into account the low specific gravity and enormous density of the mass of superstition in the world, the wrong thinking, sometimes even amounting to insanity, resulting from crude and mistaken pseudo-religious conceptions, which have done and will tend to do infinitely more harm to the race than the class of conceptions denominated by some writers as agnostic, and which must for centuries to come be held by the few. While one may not agree with the extreme views of Spencer, Huxley, and particularly Haeckel and others who have, as some believe, established a sort of "scientific priesthood" with a more or less one-sided, bigoted following, yet the criticisms coming from that quarter will do most efficient service in making men think and feel more rationally.

It will be gathered from the foregoing remarks that Professor Mivart's Lessons is really a criticism of the evolution school of naturalists by one who from being an extreme Darwinian has become a moderate evolutionist *sans* any taint of what is known as materialism, and who con-

[1] *Lessons from Nature, as manifested in Mind and Matter.* By ST. GEORGE MIVART. New York: D. Appleton & Son. 1876. 12mo, $2,00.

sequently entertains views which enable him to acknowledge the pope, and perhaps Lamarck as well, as his master.

Mr. Mivart believes that man forms a kingdom by himself, and that "he differs absolutely, and therefore differs in origin also;" least of all does he — and he thus agrees with Mr. Wallace — believe that he originated "from speechless, irrational, non-moral brutes." Our author's opinions on the nature of instinct strike us as very old-fashioned and irrational. He thinks there is "no need whatever to credit brutes with intellect: first, because all the phenomena they *do* exhibit can be accounted for without it, while they *do not* exhibit phenomena characteristic of a rational nature."

The chapter on mimicry is an excellent criticism on this phase of Darwinism, which with sexual selection is one of the weak buttresses of the theory of natural selection. In considering the last-named theory of Mr. Darwin, Professor Mivart brings forward the objections made to it in his former work, Genesis of Species. He shows that Mr. Darwin has modified his own view of his own theory, until he is led to regard it as "the most important, but not the exclusive means of modification." Mr. Mivart's own views coincide with those of Professor Parsons, of Cambridge, Mass., and Professor Owen, of London. We are not so sure that the theory of natural selection will not in the future hold a subordinate place and form but a single phase of a many-sided theory, of which the corner-stone has possibly not yet been discovered. Meanwhile we must say that such hearty, trenchant criticism as that of Mr. Mivart is a healthy sign in a country like England, where personal authority exercises such sway over the minds even of agnostics. It should be remembered, however, that Mr. Darwin, if he has not proposed a theory which will be universally satisfactory as a working hypothesis, has sown the seeds from which will arise a plenteous harvest of new facts and suggestions which may lead to the discovery of a true and comprehensive theory of evolution. His methods are legitimate and truly scientific. We miss in the Lessons from Nature any proper appreciation of Mr. Darwin's labors, and regret that in this, as well as in criticisms by other authors, a truer appreciation is not shown for Mr. Darwin's methods and his personal genius.

Professor Mivart is one of the foremost anatomists in England. His literary and philosophical ability, as well as polemical skill, shine in these Lessons; and we confess that when a good Catholic heartily indorses a theory of evolution, though quite opposed to a mechanical theory, as pure Darwinism perhaps is, we feel quite satisfied that the world is progressing.

DOLBEAR'S ART OF PROJECTING.[1] — So frequently is the magic lan-

[1] *The Art of Projecting.* A Manual of Experimentation in Physics, Chemistry, and Natural History with the Porte Lumière and Magic Lantern. By PROF. A. E. DOLBEAR. Illustrated. Boston: Lee and Shepard. 1877. 12mo, pp. 158. $1.50.

tern used in lectures upon natural history that a manual of the use of the lantern and of the art of projecting in general is a timely publication. Professor Dolbear's manual is in all respects excellent, being simple, practical, and fully illustrated. Besides the porte lumière and magic lantern, other apparatus is described and figured, so that the beginner in the art of projecting can readily acquire the knowledge which with practice will enable him to succeed.

RECENT BOOKS AND PAMPHLETS. — Median and Paired Fins; a Contribution to the History of Vertebrate Limbs. By James K. Thatcher. (From the Transactions of the Connecticut Academy. iii. 1877.) 8vo, pp. 29. 12 Plates.

Palæontological Bulletin. No. 24. A Continuation of Researches among the Batrachia of the Coal Measures of Ohio. By E. D. Cope. (From the Proceedings of the American Philosophical Society, February 3, 1877.) 8vo, pp. 12.

Notes on the Appearance and Migrations of the Locust in Manitoba and the North west Territories. Summer of 1875. By G. M. Dawson. (From the Canadian Naturalist.) 8vo, pp. 20.

On the Genus *Merycochœrus* (Family Oreodontidæ), with Descriptions of Two New Species. By G. T. Bettany. (From the Quarterly Journal of the Geological Society for August, 1876.) 8vo, pp. 14. 2 Plates.

Onion Smut; an Essay presented to the Massachusetts Society for promoting Agriculture. By W. G. Farlow. Boston. 1877. 8vo, pp. 15.

Geographical Surveys in the United States. Remarks upon Professor J. D. Whitney's Article in the North American Review, July, 1875, concluding with an Account of the Origination of the Pacific Railroad. By Gen. G. K. Warren. Washington. 1877. 8vo, pp. 28.

Science Lectures at South Kensington. Outlines of Field Geology. By Professor Geikie. With Illustrations. 12mo, pp. 61. 25 cents. The Absorption of Light and the Colors of Natural Bodies. By Professor Stokes. With Illustrations. 12mo, pp. 43. 20 cents. London and New York: Macmillan & Co. 1877.

On the Classification of some of the Lower Worms. By C. S. Minot. (From the Proceedings of the Boston Society of Natural History.) 8vo, pp. 9.

Notes on the Ancient Glaciers of New Zealand. By Israel C. Russell. (From the Annals of the Lyceum of Natural History.) 8vo, pp. 14. With a Map.

Geological Survey of Alabama. Report of Progress for 1876. By E. A. Smith. Montgomery, Ala. 1876. 8vo, pp. 100.

Brehms Thierleben. Allgemeine Kunde des Thierreichs. Grosse Ausgabe. Zweite umgearbeitete und vermehrte Auflage. Erste Abtheilung. Säugethiere. Erster Band. Leipzig. 1876. New York: B. Westermann & Co.

Sketch of the Origin and Progress of the United States Geological and Geographical Survey of the Territories. F. V. Hayden, United States Geologist-in-Charge. Washington. 8vo, pp. 15.

Hypsometric Map of the United States. By Henry Gannett. 1877. Drainage Map of Colorado. Primary Triangulation. By J. T Gardner and A. D. Wilson. Topography. By A. D. Wilson, G. R. Bechler, Henry Gannett, G. B. Chittenden, and S. B. Ladd. Department of the Interior. 1877. United States Geological and Geographical Survey of the Territories, F. V. Hayden in charge.

Annual Report upon the Geographical Surveys west of the One Hundredth Meridian, in California, Nevada, Utah, Colorado, Wyoming, New Mexico, Arizona, and Montana, by George M. Wheeler, 1st Lieut. of Engineers, U. S. A., being Appendix JJ of the Annual Report of the Chief of Engineers for 1876. With Topographical Atlas Sheets. Washington, 1876. 8vo, pp. 355.

Annual Report of the Board of Regents of the Smithsonian Institution for 1875. Washington, 1876. 8vo, pp. 422.

GENERAL NOTES.

BOTANY.[1]

CROSS-FERTILIZATION OF ARISTOLOCHIA. — Mr. H. G. Hubbard, now traveling in Jamaica, has communicated to a Western paper some interesting notes on the natural history of the island. His observations on *Aristolochia* are fully confirmatory of the studies of others in the case of *Aristolochia clematitis*. "I have had an opportunity of examining the flowers of *Aristolochia grandiflora*, the 'Dutchman's pipe,' called here the 'John Crow,' or 'carrion flower,' from the putrid stench which it exhales. This flower is one of the largest known. The tube or bowl, about a foot long as it hangs from the vines, makes a very good imitation of the Dutchman's china pipe, but the mouth of the bowl turns forward and expands eight or ten inches in diameter, and from the lower edge of this dangles a slender tail, about a foot long. The whole flower is spotted green and purple, like a diseased liver. Notwithstanding its vile odor and uncanny look, it is the most interesting of flowers. The tube is divided into three chambers by constrictions and valves furnished with backward-pointing bristles, the whole forming a trebly guarded fly-trap. The outer chamber alone gives out the carrion odor, attracted by which, insects enter, and finding themselves deceived try to escape, but the long, recurved bristles which line the walls entangle them when they turn back, but favor their progress through the second trap and into the second chamber beyond. Finally they find their way through the third and last trap, into the third chamber. And here you will find small flies and beetles by dozens, if you open the blooming flowers. Now what is the object of this evident contrivance? The flower is not insectivorous. The entrapped insects are always found alive and in good condition, no dead ones in any of the chambers. In fact, the last one, which they must eventually reach, and which also contains the floral organs, seems to have been especially contrived for their comfort and convenience. It is spacious, unencumbered with bristles, except just about the entrance, where a perfect forest of them renders escape into the preceding chamber impossible, and moreover about the floral organs an abundance of nectar supplies them with food. There is a fine stumbling-block in the way of the believer in the laws of cross-fertilization. As Professor Gray would say, this plant seems to be formed on the plan of 'how not to do it.' Skeptics have pointed triumphantly to the *Aristolochia* as a plant which, with the utmost ingenuity, has provided for insuring self or close fertilization. They had opened flowers in full bloom, found the anthers pouring forth pollen, and the imprisoned insects skipping about the inner chamber completely dusting themselves and its walls with the yellow grains. The stigmatic surface, too, had long been fertilized, its lobes had closed, and having performed its office

[1] Conducted by PROF. G. L. GOODALE.

the pistil was withering away. The fact of self-fertilization in this plant seemed proved. Nature, however, does not disclose all her secrets on the first inspection, and a more careful study of this flower in all its stages will show that its wonderful machinery is contrived solely for securing cross-fertilization through the agency of insects, and that it cannot fertilize itself. In fact the anthers and stigma in any flower *are never open at the same time.* The mystery is explained when we examine the flowers that have blossomed and are withering: *the trap is open and the insects all flown.* Each of the three constrictions, which were at first so narrow as only to admit of a small insect pushing its way between the hairs, is now gaping widely open, and all the bristles so wilted and flaccid as to offer no impediment to their escape. Now turning to a bud just bursting into flower, we find the bristles rigid and the trap set. The stigma is now widely open and ready to receive pollen, but the anthers tightly closed and their pollen quite green. Each flower has then a double duty to perform: first, to catch insects which have been liberated by some flower previously in bloom, and to effect its fertilization with the pollen which they bring; second, to feed and hold them there until its stigma has closed and its anthers burst. And, finally, it opens its trap and sends them forth with unimpaired vigor and a fresh load of pollen for the next flower that blooms." — (Kingston, Jamaica, February 28, 1877.)

PINUS MITIS. — The attention of botanists living in the Middle States is directed to this tree, which has become rare in the North. As one of the most valuable of North American timber trees, attention has been drawn to this species as suitable for forest culture in many parts of the United States, and it is desirable to procure seed for this purpose from as far North as possible. According to the younger Michaux, *Pinus mitis* was found in his time in New York, Connecticut, and Western Massachusetts, and Mr. Lapham includes it in his catalogue of Wisconsin plants, but there is no evidence that this tree grows so far north at the present time.

Botanists finding *P. mitis* in the States above mentioned, or in Pennsylvania, New Jersey, Ohio, or Michigan, are requested to communicate with the director of the Botanic Garden of Harvard University, Cambridge, Mass. — C. S. SARGENT.

FLUORESCENCE OF CALYCANTHUS. — A decoction of the bark of the *Calycanthus floridus*, also known as "sweet shrub," is strongly fluorescent. My attention was recently drawn to this fact in examining a mixture of the bark in glycerine, which I had prepared in order to extract the pleasant odor of its essential oil. The vial containing the bark and glycerine when looked at askance emits a rich, bluish shimmer. On comparing a decoction of the bark of this shrub with that of the *Æsculus*, or buckeye, by concentrating the sun's rays with a lens into a cone of light passing through the liquids, I discovered that the Calycanthus decoction

is strikingly superior in intensity and purity of blue color in the fluorescing cone to the Æsculus decoction. — ROBERT TOOMBS, M. D., Washington, Georgia.

ON THE TRANSFORMATION OF CRYSTALLIZABLE SUGAR INTO CELLULOSIC PRODUCTS. — M. Durin gives in *Annales des Sciences Naturelles* (iii. No. 4–6) a detailed account of a peculiar fermentation observed by him. Under certain conditions, a solution of crystallizable sugar is converted into cellulose either firm and organized, or swollen, and into inverted sugar. He has never noticed the formation of cellulose from glucose.

RESPIRATION OF ROOTS. — Two different functions have been confounded under the term respiration, namely, assimilation and true respiration. The first of these takes place only through the agency of chlorophyll or its equivalent, and under the influence of light; the latter is common to all plant organs when growing or working. Assimilation is a process characterized by the production of carbhydrates from carbonic dioxide and water, with disengagement of oxygen; respiration involves the oxidation of assimilated matter and is accompanied by the formation of carbonic dioxide. Dehérain and Vesque have lately reëxamined the subject of root respiration, and they have published the following results: —

First: oxygen is necessary for all plant organs. It is not enough for a living plant to have its upper part in the air; it is requisite that the roots themselves should find oxygen in the atmosphere of the soil. Second: absorption of oxygen by the roots is attended by only a slight evolution of carbonic acid; thus roots produce a partial vacuum in the receptacles in which they are confined. Third: the disengagement of carbonic acid takes places as well in an atmosphere deprived of oxygen as in an atmosphere containing it; whence we may conclude that the carbonic acid evolved does not come from a superficial oxidation of organs in a state of decomposition, but as a consequence of the circulation of gases in the plant.

THREE FEET OF FERN-SPORES. — Bureau and Poisson have examined a substance found in large quantities in a cave at Reunion Island. The cave is ten metres in depth by six metres square, and is covered to a depth of more than a metre by a yellow, soft, insipid, inodorous substance, which crumbles under the fingers to an impalpable powder. The dry powder burns without flame or odor, but when moistened gives off during combustion much smoke and odor of a burning plant. By exclusion they have decided that this matter consists of the spores of species of ferns, probably Polypodiaceæ. The spores are not those of Lycopodiaceæ, according to the writers, but they have the shape, markings, and *color* of the spores of the Polypodiaceæ with large fronds now occurring on the island.

HEATHER IN NOVA SCOTIA. — Professor Lawson adds to the locali-

ties of *Calluna vulgaris* on this continent six other stations, and in an interesting paper on the subject gives the following as his conclusions: *Calluna vulgaris* is an indigenous plant, and still exists as such in very small quantity on the peninsula of Halifax. In Point Pleasant Park, at Dartmouth, and possibly in other places, the stations for the plant are artificial, but the plants are probably native. "The various traditions as to the foreign origin of the heather are not unlikely to have been suggested by the desire to account for the presence of what was regarded as necessarily a foreign plant rather than by actual historical facts."

Broom in Cape Breton, and *Rhododendron maximum* at Sheet Harbor, Nova Scotia, are discoveries reported by Professor Lawson.

Analytical Tables. — Professor Ordway, of the Massachusetts Institute of Technology, has sent us copies of analytical tables of the orders of Phænogamia, and of the suborders of Cryptogamia. These are careful synopses of the classifications of Lindley, Hooker and Baker, Schimper, Debat, Müller, Rabenhorst, Harvey, Tuckerman, and Cooke. In view of the present lack of any hand-book on Cryptogams, for the needs of general students, the second table may be found convenient. The author has been most painstaking in his work.

On the Porosity of Wood. — Professor Sachs has published a preliminary communication on this subject in which he gives the results of his recent observations and experiments. The present treatment of the matter is new in some respects, and the conclusions are interesting. An abstract of these will be given in the next number of the Naturalist.

Iris. — Our eastern species of this genus need a thorough revision. The manuals give but two tall species in the Northern States, a broad-leaved and a narrow-leaved one, that is, *I. versicolor* and *I. Virginica* of Linnæus, considering the latter as identical with the *I. prismatica* of Pursh. Now Mr. J. G. Baker, of Kew, in a recent revision of the genus, recognizes two broad-leaved species under the two Linnæan names, and restores Pursh's name for the narrow-leaved plant. Two broad-leaved forms have certainly been cultivated in the European gardens even from the time of Linnæus, and have always been known there by his names and considered distinct. As described by Mr. Baker, and as shown by figures, the most obvious difference appears to be one of size, *I. Virginica* being the taller and stouter, with larger and deeper-colored flowers. Can we find in our wild plants any differences upon which this distinction can be maintained?

Mr. Baker says also that *I. tenax* (a narrow-leaved Oregon species similar to *I. prismatica*) is found in New Brunswick and Canada, and if so it should be looked for within our limits. Moreover the range of all these species is uncertain, especially toward the south, and the southern species generally need revision fully as much as the northern ones. It is probable that careful comparison will reveal new forms from there. The attention of all our botanists is requested to this matter during the

coming season, and specimens of flowers, fruit, and roots, fresh or dried, from any part of the country, may be sent to the Botanic Garden, Cambridge, and will be of service. — SERENO WATSON.

BOTANICAL NOTES FROM RECENT PERIODICALS. — *Flora*, No. 4. Schulzer, Notes on Fungi. Batalin, Mechanism of the Movements in Insect-Eating Plants (not yet finished).

Botanische Zeitung, 1877, No. 6. J. B. Jack, On European Hepaticæ (continued in No. 7). No. 8. Pancic, A new Conifer in Servia. Report of Scientific Societies. No. 9. Celakovsky, On the Greenish Ovules of Trifolium repens. (These are often distinctly foliaceous, and are regarded by the author as metamorphosed leaflets of the carpel.) This paper is continued in No. 10.

ZOÖLOGY.[1]

WINTER BIRDS OF ARKANSAS. — Perhaps it will interest the readers of the NATURALIST to know of some birds which make Central Arkansas their winter quarters. The past winter has been the coldest known for many years, with considerable snow. The following list is certainly far from complete, as we have only been observing birds for a single season. Among the thrushes we have occasionally seen our familiar friend, the robin (*Turdus migratorius*), and the hermit thrush (*T. pallasi*), but usually they desire somewhat warmer weather than we have had this winter.

The mocking-bird (*Mimus polyglottus*) is very plenty around old plantation houses, and exhibits the peculiar markings of the Arkansas specimen spoken of by Baird in his Review of American Birds, page 49. It has an unusual amount of white upon its plumage, and the outer tail feathers clear white.

Perhaps the most abundant bird of the past winter has been the bluebird (*Sialia sialis*); its food consists largely of the berries of the black gum (*Nyssa multiflora*).

The diminutive golden-crowned kinglet (*Regulus satrapa*) has been observed, as have the tufted titmouse (*Lophophanes bicolor*), the southern black-capped chickadees (*Parus atricapillus* var. *Carolinensis*), the nuthatch (*Sitta Carolinensis*), and the house wren (*Troglodytes aëdon*). The gay tanager (*Pyranga æstiva*) in his bright red plumage and the female with her more subdued hue have enlivened the landscape all winter.

The snow-bird (*Junco hyemalis*), following the snow-storm southward, was with us in great numbers for about three weeks. The meadow-lark (*Sturnella magna*) is common, so is the noisy blue jay (*Cyanurus cristatus*), proclaiming with harsh notes his close relationship to the crows. The kingf[illegible]le *alcyon*) was occasionally seen hovering over the waters c[illegible]d River in quest of food.

[1] The departmen[illegible]nd Mammalogy are conducted by Dr. ELLIOTT COUES, U. S. A.

The woodpecker family has attracted our attention all winter by its many representatives, as follows: —

Logcock (*Hylotomus pileatus*), downy woodpecker (*Picus pubescens*) yellow-bellied woodpecker (*Sphyrapicus varius*), red-bellied woodpecker (*Centurus Carolinus*), golden-winged woodpecker (*Colaptes auratus*).

Among the birds of prey we have observed the barn owl (*Strix flammea* var. *pratincola*), barred owl (*Syrnium nebulosum*), and screech-owl (*Scops asio*), and the red-shoudered buzzard (*Buteo lineatus*). The latter feeds in confinement upon dead animals furnished it, but we found by experiment upon a specimen we had procured that it did not do well upon such food, for it died in a week from the time of its capture.

Here we find the turkey-buzzard (*Cathartes aura*) very plentiful. Mourning doves (*Zenaidura Carolinensis*), wild turkeys (*Meleagris gallopavo*), quails (*Ortyx Virginianus*), pigeons (*Ectopistes migratorius*), and mallard ducks (*Anas boschas*) are our winter game birds. The first of February finds the farmer in this region sowing oats and planting early garden seeds. At this time, we may say, our winter is over, and our summer birds will soon be with us again. — H. S. REYNOLDS, Judsonia, White Co., Arkansas.

THE RED-HEADED WOODPECKER CARNIVOROUS. — A friend who resides in Humboldt County, this State, gives me the following particulars of an unusual occurrence: During the summer of 1876 he raised a large number of black Cayuga ducks. It was noticed that while the birds were still very young, many of them disappeared, one after the other, and the bodies of several were found with the brains picked out. On watching carefully to ascertain the cause, a red-headed woodpecker (*Melaneopes erythrocephalus*) was caught in the act. He killed the tender duckling with a single blow on the head, and then pecked out and ate the brains. Though my friend was an enthusiast in protecting the birds and squirrels that came about his premises, this provocation was too much; the shot gun was brought into use, and his ducks were saved from further molestation by a process by which the woodpeckers were "thinned out some." — CHARLES ALDRICH, Webster City, Iowa.

ANTHROPOLOGY.

ANTHROPOLOGICAL NEWS. — The course of lectures on anthropology, commenced in November last at the Anthropological Institute of Paris, has succeeded beyond the expectation of its founders. In the institute are united three organizations of separate origin: the Society of Anthropology; the Laboratory of Anthropology, founded by M. Broca in 1867, and which has since been attached to L'École des Hautes Études; and the School of Anthropology, founded by private subscription, and sustained by an annual appropriation of twelve thousand francs.

Upon the recommendation of the faculty of medicine, the minister of public instruction has placed at the disposal of the Institute the upper

portion of the Church of the Gray Friars, leaving to them the expense of fitting up the rooms, etc., which has amounted to about fifty thousand francs. In this structure are united the library, the laboratory, the lectures, and the museum, all of which are public. There is nothing wanting to make the course complete. The museum, which results from the union of that of the Society of Anthropology (twelve hundred skulls) and that of the laboratory (twenty-three hundred skulls, skeletons of individuals belonging to different races and of primates, skulls of mammals, prehistoric remains, and anthropological instruments), furnishes to the student the richest material for study, and to the professor all the means of demonstration necessary. We have already mentioned the opening address of M. Broca and the programme. The following table is M. Mortillet's scheme of prehistoric anthropology: —

Times.		Ages.	Periods.	Epochs.
Recent.	Historic.	of Iron.	Merovingian.	Waberian, Merovingian, Burgundian, Germanic.
			Roman.	Champdolian, Roman decadence.
				Lugdunian, Roman flourishing.
	Protohistoric.		Galatian.	Marnian, Gallic, 3d Lacustrian.
				Hallstattian, Epoch of Tumuli, 1st Epoch of Iron.
	Prehistoric.	of Bronze.	Bohemian.	Larnaudian, Epoch of the Forge, Upper 2d Lacustrian. Morgian, Epoch of the Foundry, Lower 2d Lacustrian.
		of Stone.	Neolithic. Polished Stone.	Robenhausian, 1st Lacustrian, Epoch of Dolmens.
Geological.			Palæolithic. Flaked Stone.	Magdalenian, nearly all in Caverns, Epoch of the Reindeer almost exclusively.
				Solstréan, Epoch of the Reindeer and Mammoth partly.
				Moustérian, Epoch of the Cave-bear.
				Acheuléan, Epoch of the Mammoth.
			Eolithic. Fire-flaked Stone.	Thenaisian, Tertiary.

Attention has previously been called to an original paper in the Smithsonian Report for 1875, by C. C. Abbott, M. D., on the Stone Age in New Jersey. The first thing that strikes one in reading the paper is the result that may be obtained in an uninviting field by perseverance. Dr. Abbott has found over ten thousand stone implements in New Jersey, embracing rude objects of unknown use, grooved axes, celts, hatchets, "lance-heads," "hunting-spear heads," "fishing-spear heads,"

arrow-points, knives, "skinning-knives," scrapers, hammers, "chisels and gouges," drilling stones, "breastplates," "gorgets," "banner-stones," "sculptures," pipes, pottery, paint-cups, hoes and shovels, "corn mills," mortars and pestles, "poggamoggons" and net-sinkers, "flaking-hammers," and polishing tools. There is manifested throughout the article a commendable zeal for North American archæology, though, perhaps, too great a fondness for classification and inventing new names, an undue confidence in the ascertained use of certain doubtful forms, and, above all, a too hasty adoption of the generalizations of some English and French archæologists, with reference to the order of culture on our continent. But as we need some adventurous spirits to peer into dark places, these venial faults must not deter us from commending the zeal of Dr. Abbott, and bidding all such "to go up and possess the land."

The next meeting of the Congrès International des Americanistes will be held at Luxemburg, September 10–13, 1877. The following is the programme in full: —

History. The civil legislation of Mexico under the Aztecs and of Peru under the Incas compared. Critical examination of the sources of the history of Central America. Discovery and colonization of Brazil. When and why the New World was called America.

Archæology. General characteristics of the Maya architecture in Yucatan. Of the use of copper in ante-Columbian America. The mound-builders, their origin, antiquity, civilization, and history.

Linguistics. Peculiar characteristics of the Tapi-Guarani family. The grammar of American languages compared with that of the Uralo-Altaic languages. Eskimo dialects compared with other languages of America and with those of Asia.

Palæography. Decipherment of Maya inscriptions and manuscripts. Of the phonetic element in Mexican writing. To what period of American history do the paintings called Mexican hieroglyphics belong? To indicate, as far as possible, the date of the most ancient documents known in that writing. To show what influence was exerted on the development and use of the Mexican figurative paintings by the arrival of the Spaniards.

Anthropology and Ethnography. Of the antiquity of man in America. Of the tradition of the deluge in America, and particularly in Mexico. Ethnographic classification of the inhabitants of Guiana.

M. Bertrand contributes to the *Bulletin de la Société d'Anthropologie*, 1876, pages 100 and 173, papers upon the first Celtic tribes known to the Greeks, who are the only people to mention the Celts previously to 200 B. C. Following up the theme, on page 128 of the same volume, M. Gustave Lagneau has a paper upon the Ethnic Distinction between the Celts and the Gaels, and their Migrations to the South of the Alps. Whatever comes from the pen of this distinguished author is worthy of the highest commendation. The copious references to authorities are a

praiseworthy feature of this treatise. In the *Bulletin*, page 113, is a communication from E. T. Hamy, on The Negritos of Borneo, which also refers to authorities, and is accompanied by two tables, one of cranial and the other of facial measurements. A paper in the *Bulletin*, page 145, upon excavations in the dolmen of l'Aumède (Lozere), is interesting on account of a discussion which grew out of it with reference to cremation in dolmens of this description, and evidences of syphilis. — O. T. MASON.

GEOLOGY AND PALÆONTOLOGY.

THE DISCOVERY OF LÆLAPS IN MONTANA. — The carnivorous *Dinosauria* were the largest and most formidable flesh-eating animals that ever lived on the earth, the *Carnivora* of the present day being comparatively insignificant. In the Triassic period the gigantic *Bathygnathus* reduced the numbers of the reptilian life; and in the Jurassic the equally huge *Megalosaurus* devoured the herbivorous *Iguanodon*, etc. In North America the last of these saurian faunæ is abundantly represented in the lignitic beds of the West. Professor Cope has discovered during the past season numerous species of *Lælaps*, some of which were of gigantic size. One of these (*L. incrassatus*) is represented in his collections by a large part of an under-jaw, which is rarely preserved in this class of animals, but three or four others having been heretofore discovered. This animal was about the same size as the New Jersey *Lælaps*, but more robust. Several smaller species were obtained.

THE SEA SERPENTS OF THE CRETACEOUS PERIOD. — At one of the recent lectures of the course of the Philadelphia Zoölogical society, Professor Cope exhibited the greater part of the skeleton of a new species of *Elasmosaurus*. The length of the vertebral column is about forty feet, and several feet of vertebræ are wanting. The neck constitutes about half of the total length. The paddles of both pairs are preserved, which is not the case with any other specimen known. They prove to be relatively short, agreeing in this point and in the superior size of the front pair with a restoration he had published some years ago. The specimen was found in Nebraska, and the species was named *Elasmosaurus serpentinus*.

Professor Cope also stated that he had obtained on the Upper Missouri, during his expedition of the past year, a large part of the vertebral column of the *Elasmosaurus orientalis*, from beds corresponding with those in which he had originally found it in New Jersey. This species also has an enormous neck, and was of more robust proportions than the *E. serpentinus*.

THE DENTITION OF THE HERBIVOROUS DINOSAURIA OF THE LIGNITIC PERIOD. — At a recent meeting of the American Philosophical Society, Professor Cope exhibited portions of the skulls of several herbivorous Dinosauria, the huge land reptiles that during the lignitic period in North America took the place of the mastodons and elephants of later

ages. He adduced Bartram's articles in proof of the relationship of these animals to the birds which he had originally pointed out from the structure of the feet. He also showed that they possess an extraordinary dentition, much more complex than that known to belong to the same class of animals heretofore described in Europe. The teeth are arranged in vertical columns which constantly grow at the base, and which are kept in place by grooves in the jaw-bones. In one genus, *Diclonius* Cope, each tooth of a column overlaps the ends of those above and below it; while in another, *Cionodon*, nearly every horizontal section of the jaw cuts three teeth. It was estimated that there were seven hundred teeth in the mouth of the former genus at one time, and two thousand in the mouth of the latter.

THE LOWEST MAMMALIAN BRAIN. — At a recent meeting of the American Philosophical Society, Professor Cope exhibited a cast of the brain cavity of a species of *Coryphodon* from New Mexico, and described its peculiarities. He stated that it is the lowest and most reptilian type of mammalian brain known, for the following reasons: the diameter of the hemispheres does not exceed that of the medulla, which is as wide as the cerebellum. The latter is small and flat. The middle brain is the largest division, much exceeding the hemispheres in size, being especially protuberant laterally. The hemispheres contract anteriorly into the very stout peduncles of the olfactory lobes. These continue undivided to an unusual length, and terminate in a large bulbus, which is at first grooved above, and then bifurcate at the extremity. The length of the hemispheres is one fifteenth that of the cranium, and their united bulk one twenty-seventh that of the hemispheres of a tapir of the same size. Their surface is not convoluted, and there is no trace of sylvian fissure. The region of the pons varolii is very wide, and exhibits a continuation of the anterior pyramids. The large size of the middle brain and olfactory lobes gives the brain as much the appearance of that of a lizard as of a mammal.

Professor Cope stated that three, and perhaps four, other examples of this type of brain are known. The first, described by Professor Gervais, is that of the flesh-eater, *Arctocyon*, from the same lower Eocene horizon as the *Coryphodon*. The next is that of the *Uintatherium*, of the Bridger Eocene, described by Marsh, who states that the hemispheres present a sylvian fissure, in which he is most probably in error, and whose figures do not exhibit the convolutions which he claims to have found. The third is that of the *Oxyæna*, described by Professor Cope, of which the middle brain is unknown, but which is probably like that of *Arctocyon*, in view of the close similarity in other respects.

In reviewing the evidence derived from the preceding sources, the opinion was expressed that the type of brain shown to exist in the *Amblypoda* and *Creodonta* is as distinct from that characterizing the primary divisions of the *Mammalia* as they are from each other, and that

it necessitates the establishment of a special subclass for its reception, of equal rank with the groups *Gyrencephala* and *Lyencephala*. This was called the *Protencephala*, with the following definition: cerebral hemispheres smooth, small, leaving not only the cerebellum but the middle brain exposed behind, and contracting into the very large olfactory lobes in front. Cerebellum very small and flat; middle brain large. This character is sustained by that of the ankle joint, which, existing in two such distinct divisions as the *Amblypoda* and *Creodonta*, may be found to characterize the entire subclass, but this is not yet certain; it is as follows: tibio-astragalar articulation flat and without groove or segment of pulley.

This subclass stands below the *Lyencephala* in its position, approximating the reptiles in the points above-mentioned more nearly than the latter do. It includes two orders: one ungulate, the *Amblypoda*; the other unguiculate, the *Bunotheria*. To the former belong the suborders *Pantodonta* and *Dinocerata;* to the latter the *Creodonta* and probably the *Tillodonta* and *Tæniodonta*. Whether the *Mesodonta* belong to it is not certainly ascertained, while the *Insectivora* do not belong to it, as they are rightly placed in the subclass *Lissencephala*.

GEOGRAPHY AND EXPLORATION.

FARTHER NEWS FROM STANLEY. — Three letters written in August, 1876, have been received from Stanley. At that time he had reached his old quarters at Ujiji. He had circumnavigated Lake Tanganyika, which is about as large as Lake Michigan. He has apparently added little to what Cameron discovered. He describes a section of the Lukuga River, about eight miles in length, in order to prove that Captain Cameron was incorrect in regarding it as the outlet of Lake Tanganyika, though such, adds Stanley, it is destined to become. He explored Lukuga to a point three miles beyond that reached by Cameron, discovered that the outward current gradually ceased, and that the river-bed finally changed into a marsh thickly covered with papyrus. Following the borders of this marsh for two miles further, he again reached a stream, the waters of which flowed distinctly westward, passing by an abrupt gorge through a mountain range one thousand two hundred feet high. It is called the Luindi, and is a tributary of the Lualaba of Livingstone. Mr. Stanley asserts that the level of Tanganyika Lake is rising so rapidly that in a few years the waters of the Lukuga and the Luindi will unite, the intervening marsh disappear, and a permanent outlet thus be created.

THE TOPOGRAPHICAL SURVEY OF NEW YORK. — The governor of New York having opposed the passage of a bill in the legislature of that State making appropriations for continuing the state geographical survey, begun so well by Mr. James T. Gardner, resolutions urging the passage of the bill have been sent in by the leading universities and colleges

of the State, and it will be a great pity if the public sentiment of the State is disregarded by its executive. A topographical survey of New York by one of the leading geographers of the country would be a model for other states to follow.

MICROSCOPY.[1]

A Foreign View of American Microscopy. — Mr. Henry Crouch, the well and favorably known London optician of that name, who spent a considerable part of last summer at Philadelphia in the double capacity of a British commissioner and an exhibitor, improved the opportunity to become acquainted with many of our microscopists, and to study the various styles of instruments exhibited at the Centennial. His contribution on the subject, addressed to the Queckett Club after his return home, is of more than ordinary interest on account of his special and technical knowledge of the subject, his position as a fellow exhibitor, to which he candidly alludes as a peculiar feature in the case though not a motive to control his statements, his comparative independence of local sympathies and prejudices, and his evident feeling of good will and cordiality towards those whom he met while here. He heartily acknowledges the hospitable treatment received in this country, and intimates that a vacation spent here is a rare pleasure, a statement which elicited from the president of the club a hearty assurance of reciprocation in case any of our microscopists should visit London.

Mr. Crouch mentions with pleasure and surprise the interest and promptness with which the progress of microscopy in England is followed up in this country. He notices the large number of students of diatoms, due, he suggests, to the great abundance of the fossil deposits here, and the comparative unfamiliarity with other forms of pond life. He regrets, as we do, the absence from the circle of exhibitors of some eminent competitors for success in the same department of manufacture.[2]

The very general adoption of the Jackson form of stand in this country, which has always been a fact, Mr. Crouch regards as an encouraging confirmation of his uniform belief and practice; the continental model being used, as far as he noticed, only by those who employ the microscope in some narrow specialty, and for the most part without accessories. The same remarks would apply to the binocular, and they are certainly correct if the specialties be understood to include histology and pathology, for which many of the English and American accessories are not needed, or at least not popular. As further peculiarities of the

[1] Conducted by Dr. R. H. Ward, Troy, N. Y.

[2] The opinion having been expressed in the Naturalist, December, 1876, page 730, that the insinuation that Tolles' lenses were not exhibited at Philadelphia because they would not be properly examined there, must have been authorized without serious thought, Mr. Stodder desires the correction made that the reason given for withholding the lenses was not intended to be insinuated but distinctly stated in the case referred to, that it was adopted after mature consideration, and that he still considers it justifiable and proper.

American stands, he notices the greater prevalence than in England of stands having the limb supported by one pillar instead of two, though what happened to come before his notice gave a greatly exaggerated idea of the proportion of single-pillar instruments used here, the more general use of the [Zentmayer] glass stage, the general absence of a concentric stage rotation, except in the larger stands, the hinging of the mirror-stem for better managing oblique light, and the new plan of swinging mirror and substage together as now made by both Zentmayer and Gundlach. He mentions Zentmayer's new portable microscope very favorably, along with one by Ross, and claims the centring adjustment now used on the best stands as his own, though contested by two claimants here.

Of objectives he with very good taste hesitates to speak comparatively, adding a good-natured allusion to the well-known sensitiveness on this subject of makers, and the peculiar weakness of each for considering his own unquestionably the best in some important particulars. Subsequent discussion, however, drew out the opinion that the work of some American opticians was very good, and differed from others (abroad) only in some few peculiarities. He had seen some of Mr. Tolles' objectives which he had not found equaled elsewhere, though his impression was that he pushed the angle of aperture too far, and sometimes to the positive detriment of his lenses. Microscopes of the better class he believed were produced in America fully as good as in England, though at far higher prices. Micro-photography he finds more extensively cultivated here than at home, with an evident influence on the construction of objectives, especially in regard to the angular aperture of the higher powers, the advantage of which he thinks is at least questionable, and from his own recent observations he is inclined to believe that "there are other and important directions in which the energies of those engaged in the manufacture of objectives can be more profitably employed."

He finds the accessories exhibited of the usual character, and not calling for special remark, though he states that he has had "the pleasure of receiving many valuable hints respecting the improvement and modification of some of the accessories from Dr. Woodward, of Washington, Dr. J. G. Hunt and Mr. Holman, of Philadelphia, Dr. Ward, of Troy, and other microscopists," which he hopes to have an opportunity of carrying out and submitting to further notice.

The mounted objects by Mr. Walmsley, of Philadelphia, Dr. Beattie, of Baltimore, and Dr. J. G. Hunt, of Philadelphia are mentioned with praise; the vegetable preparations, transparent and double stained, by the latter person are regarded with evident enthusiasm as remarkable illustrations of vegetable structure mounted in an unsurpassed manner. Dr. Hunt's exquisite transparent vegetable preparations can hardly be better appreciated anywhere than here, but that they should now be regarded as novelties is almost incredible. When first produced many years

ago they were believed to be a large and important contribution to the progress of microscopy, but the methods worked out by Dr. Hunt were so unselfishly communicated, and the objects so liberally distributed and so largely studied and imitated, that they have long since become common property. Even the addition of double (vegetable) staining, systematized and rendered practically successful through the talented labors of Dr. Hunt and Dr. Beattie, is no longer spoken of as a novelty here.

In comparison, if not in contrast, with these criticisms by a practical foreign artisan may be noticed a critical paper on the same subject by a leading American botanist and philosophical microscopist, Dr. J. G. Hunt, just published in the *Cincinnati Medical News*. Dr. Hunt discusses American as compared with foreign microscopes at the Centennial.

The new Ross stands he considers superior to the old form in improved appearance, greater accuracy of motion, more steadiness with less clumsiness, and a binocular prism not moved by focusing, but the stage is considered still too thick, the change of power during fine adjustment a perceptible fault, and the finish only moderately good. Beck's large stand is considered the best of foreign make in form and finish, though defective in lacking centring adjustments to the rotating stage (which we think were added to some of the stands exhibited at the Centennial), and in want of durability in the stage movements. The stands by Mr. Crouch are considered excellent and durable, and successfully cheapened without sacrificing commercial good work. His claim of the adjustable concentric stage is denied in favor of Zentmayer who introduced it sixteen years ago. [Mr. Zentmayer undoubtedly introduced this adjustment long ago with a screw-driver movement, which he still prefers, while Mr. Crouch has more recently added milled heads so that it can be moved without tools.]

The Nachet stands are considered neither elegant, convenient, nor durable, and the Hartnack instruments, not exhibited, are rated as clever working instruments in a restricted way, but inferior to the English and American.

German instruments are not esteemed, and are scarcely considered instruments of precision at all.

Of American stands only Zentmayer's are specially discussed, and these are judged to be preëminent, being the best microscopical work on exhibition, and having no superiors anywhere. His "American Centennial" stand is considered superior in workmanship and design to any others in the exhibition or elsewhere.[1] The hinging of the bar which carries all the illuminating apparatus, including the mirror, at the level of the object on the stage so as to revolve around that object, is credited exclusively to Zentmayer, and stated to have been wanting in the Rochester

[1] The principal novelties introduced in the construction of this stand have been already specified in the NATURALIST. We heartily concur with Dr. Hunt that this is the best first-class stand yet produced in the world.

instruments exhibited at the *opening* of the exhibition. [It was certainly present in the Rochester instruments exhibited during the summer.] This would give the priority in this important improvement clearly to Mr. Zentmayer.

The so-called student's stands are mentioned with the intimation that too many of them are unfit for use, and with an earnest appeal for better workmanship in their construction.

Objectives are discussed without restriction to those exhibited at Philadelphia. Indeed it would be hardly possible to say anything comprehensive about them otherwise, since Mr. Tolles' work could not be overlooked in such a discussion.

Mr. Wenham's patent lenses, in which corrections are obtained by a single flint lens, were considered to give great promise, but to be so unsuccessfully mounted as to compel a suspension of judgment in regard to them. Mr. Crouch's lenses were considered excellent and exceedingly fine for their cost, though without extraordinary optical qualities, strikingly resembling in corrections the Wenham lenses. Beck's lenses retain their character for excellent optical properties, being as nearly achromatic as possible without aiming at maximum angle. Their mounting, however, is poor in design and execution. The new Powell and Lealand one-eighth ranks highest of all foreign objectives yet seen, and marks a new era in English microscopy. It gives a bluish-green light, with sharp and accurate definition, and a good image to the edge of the field. The mounting is superb, and the American [Tolles'] plan of traversing the back combination is adopted.

The German objectives are not commended, the lower powers being judged unfit for use, and the high ones to fail in comparison with our lower powers. The brass work is considered inferior, and the lenses show a want of finger skill.

Of American lenses he speaks chiefly of those by Mr. Tolles, because those of other makers have disappointed him. He considers that there are greater optical possibilities in Mr. Tolles, in the construction of lenses for the microscope, than in any other maker. His lenses are often thought faulty because not understood. No two of them are alike, but this is due, he is satisfied, not to unequal execution, but to a special change in each case to obtain a higher degree of some particularly desired quality. Neither are penetration and resolution incompatible to the extent claimed by the theorists. Some of Mr. Tolles' lenses of extreme angle have a penetration so extraordinary that they form the best lenses known for histological work by central light, showing details with a brilliancy not otherwise seen. A recent Tolles one-tenth has the same power as the new Powell and Lealand one-eighth, but with clearer and more brilliant definition and greater penetration. It adopts the [Wales'] method of adjusting for wet and dry by the screw-collar, while the one-eighth has a separate front, a less convenient plan.

Dr. Hunt fears that micro-photography, especially that whose best results are obtained by oblique light, may temporarily retard the best construction of lenses for histological work which is not proven to be best accomplished by lenses specially corrected for obliquity. He thinks that our best lenses have optical capacities not yet fully developed, and that improvement in illuminating apparatus, particularly that for obtaining accurate central illumination, modified or concentrated at will, is more needed at present than further improvement in lenses.

Of microscopical objects he believes that the best work is always kept at home, and that with few exceptions we receive from Europe only what is unsalable there. The finest pathological work he has seen, at least that retaining the most structural details if not the most neatly mounted, was produced at the Army Medical Museum at Washington. In demonstrating and mounting botanical subjects, he considers this country immeasurably in advance of all others. He does not state (what should be stated) that this advance is very largely due to his own distinguished labors. Biological science, however, is not satisfied with microscopical slides, but turns to the living objects for a knowledge of structural details, and even the mounted preparations of the present and the future must show the whole structure of the cell, and not its empty shell, however beautifully displayed.

Obituary. — Died at Boston, Mass., on Monday, March 19th, Edwin Bicknell, one of the most genial of men and one of the most skillful of workers with the microscope. Outside the circle of his personal friends, among whom he was conspicuous for his cordiality and hearty good will, he was best known and will be longest remembered for his highly successful work in the preparation of microscopic objects. His slides, especially those of hard sections, have scarcely been equaled by any other maker. The exquisite slides which he sent out some years ago, by an arrangement with the Essex Institute of Salem, Mass., under the name of the Essex Institute Microscopical Works, have been followed ever since by an unbroken succession of excellent work.

SCIENTIFIC NEWS.

— From a recent letter from Dr. L. de Koninck, of Liége, Belgium, to Professor Hayden, we learn that the king of Belgium last year proposed a prize of twenty-five thousand francs to be awarded annually to the best memoir on the history of the country, its relations to foreign countries, sciences, etc., which prize even foreigners are allowed to compete for at certain periods on specific subjects. The king has also initiated an important movement toward the exploration of Africa. The subscriptions for this purpose are already quite large, and inspire the hope that strong aid can be given to the brave men who desire to devote

themselves to the emancipation of the negroes in their own country and thus destroy the last vestiges of slavery.

The Geographical Society, which has just been established under the presidency of General Liagre, perpetual secretary of the Academy of Brussels, is progressing finely.

The Belgian government has ordered the issue of a new edition of Dumont's Geological Maps. The House has appropriated 9700 francs for the purpose of collecting the necessary materials for a map on a large scale, $\frac{40}{1000}$, the entire cost of which will be 1,300,000 francs; it is to be completed in fifteen years. The House has made an additional appropriation of 10,000 francs for the publication of the manuscripts left by Dumont, which will be printed the coming year.

A still more important movement for the advancement of science has just taken place in the creation of the Annals of Natural History of the Museum of Brussels. These Annals will be published in large quarto volumes containing many plates in quarto or folio, according to the subjects, and are especially intended to inform the learned public of the scientific wealth of the galleries of the museum. The first volume will be devoted to the description of the rich collections of the fossil remains of the cetaceans and other sea mammals, gathered at Antwerp during the work on the fortifications. This volume, of which eighteen plates folio are already finished, will be written by the learned zoölogist, J. van Beneden. The second volume will be prepared by Dr. de Koninck, one of the most learned palæontologists in Europe, and will embrace the Carboniferous fossils of Belgium, forming a series of 1000 to 1200 species, all of which will be described and figured within three or four years, provided the health and vigor of the distinguished savant does not fail him.

The third volume, by Dr. H. Nyst, will treat of the Tertiary fossils of Belgium, beginning with the most recent ones, as the Crag. of Antwerp. Several plates for this volume are already finished. Other volumes of no less importance are in a state of preparation and will occupy their proper places in the series. These publications will be prepared at the expense of the government and under the direction of M. E. Dupont, director of the museum, their authors, however, being entirely independent as to their opinions and work. In closing his letter Dr. de Koninck remarks with commendable pride: "On glancing at the preceding you will be satisfied that our country, after remaining almost stationary, for a period of twenty years, has taken a decidedly fresh start in scientific matters, aided and favored by our government, our Chambers, and especially by our king. Let it be well understood that besides all this we possess not only the Academy, but also a certain number of scientific societies, namely, the Royal Society of Sciences, Liége; the Entomological and Malacological societies, of Brussels; the Society of Science, of Hainault; the Association of Engineers, of Liége, and many other

less important ones, which, however, have a legitimate existence. You see we have not much reason to complain of the sacrifices of our government, which though considerable, cannot equal those we impose on ourselves with regard to the resources we dispose of. Therefore, please send us, to facilitate our researches and to lend us strength and courage, all the publications you can spare. Help by keeping us constantly advised of the scientific progress of your country, and we promise to reciprocate. You will receive very soon the products of our scientific activity. This will be a fair exchange of thought no fiscal law can prevent and which surely will benefit both progress and humanity." — F. V. H.

— The council of the Geological Society of London have awarded the Bigsby medal to Prof. O. C. Marsh, of Yale College, in recognition of the great services which he has rendered to the palæontology of the vertebrata.

— We are glad to announce that Dr. Elliott Coues has kindly consented to edit the department of Vertebrate Zoölogy of the American Naturalist, with especial reference to ornithology. Our readers may expect from this talented and genial naturalist occasional papers as well as items of ornithological news.

SCIENTIFIC SERIALS.[1]

Monthly Microscopical Journal. — March. Address of the President, H. C. Sorby (Application of the Microscope to Geology). Measurements of Rulings on Glass, by E. W. Morley.

The Geological Magazine. — March. Evidence afforded by the Planet Mars on the Subject of Glacial Periods, by Edward Carpenter. A Permian Fauna associated with a Carboniferous Flora in the Uppermost Portion of the Coal-Formation of Bohemia, by O. Feistmantel.

The Geographical Magazine. — March. Communication with Siberia by Sea, by J. Wiggins (with map of Kara Sea). The Works on the Tiber. Topographical Surveys in Asiatic Russia during 1875 by M. Venyukof. Champa. The Nile from Mruli to Dufli (with a map of the Upper Nile from surveys made by General Gordon Pasha, by E. G. Ravenstein).

Canadian Entomologist. — January and February. History of *Phyciodes Tharos*, a Polymorphic Butterfly. (*Marcia*, winter form of *Tharos*.)

Psyche. — No. 32. Bibliographical Record of Papers on American Entomology (continued in each number).

[1] The articles enumerated under this head will be for the most part selected.

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THE WILD TURKEY AND ITS DOMESTICATION.

BY HON. J. D. CATON.

I HAVE been well acquainted with the wild turkey (*Meleagris gallopavo*) of this country for over forty years, and have had good opportunities of studying it in its wild state, and for more than ten years past I have raised it in domestication, having had sometimes over ninety in my grounds at one time, and having raised more than sixty in a single year. Some observations on their habits and domestication may not be uninteresting.

My original stock was procured from eggs taken from the nest of the wild hen, in the woods, and raised under the common hen, and it has been twice replenished in the same way, on one occasion with seven individuals. The purity of the stock, therefore, cannot be questioned; but still more conclusive evidence was in the markings, so fully and accurately described by Audubon, Baird, and others. I know of no bird or animal where the markings are more constant or reliable than on the wild turkey; even to the number of bars on a given quill of the wing, for instance, which may be relied upon to identify it.

The young bird from the egg of the wild turkey, when brought up in close intimacy with the human family, becomes very tame, and when grown the males become vicious and attack children and even grown persons. I once had eight hatched out by a hen, and gave them in charge to the wife of a tenant, with stimulating promises if she raised them, and she did it nicely. They were allowed to go into the house, to fly upon the table, and to eat with the children. Until they were grown, any member of the family could go up to one and pick it up at any time, but they were afraid of strangers, and if anything excited their suspicion they would take wing and be off like a flock of quails.

At first I procured but a single pair of wild turkeys. The sea-

son they were a year old neither showed the least inclination to breed. The male was not heard to gobble, the wattles upon the neck did not turn red, and he was not observed to *strut*, as is usual with the male turkey in the breeding season. The next year he made up for all this, and the female also well repaid me for waiting. All the others I have had have bred freely when a year old.

I am now wintering the eleventh generation of the domesticated wild turkey, though the progenitors of a portion of my flock were introduced more recently. They generally occupy the South Park, about forty acres in extent, mostly covered with second-growth trees of about twenty-five years' standing, with a considerable number of old oak trees interspersed. In the park are ravines with good hiding-places. It is heavily set with blue-grass and some white clover.

The effect of domestication has been very marked. They have not deteriorated in size or in reproductive powers. They have always been healthy excepting in the summer of 1869, when they were afflicted with some disease from which about three quarters of the flock died. They have changed in form and in the length of the legs. The body is shorter and more robust, and its position is more horizontal; but most especially have they varied in color. These changes I have constantly watched. In the first and even the second generation but little change was observed. After that the tips of the tail feathers and of the tail coverts began to lose the soft, rich chestnut brown so conspicuous on the wild turkey of the woods, and to degenerate to a lighter shade; the beautiful, changeable purple tints on the neck and breast became marked with a greenish shade; the bristles on the naked portions about the head became more sparse or altogether disappeared; the blue about the head and the purple of the wattles were replaced by the bright red observed on the tame turkey-cock; the beautiful pinkish-red of the legs became dull or changed to brown. The next year, or when the bird was in its second year's growth, say in the third generation, these marks of degeneration would on most of the specimens, especially of the cocks, disappear, and the plumage would show the thorough-bred wild turkey. Each succeeding generation shows these changes to be more pronounced, but each year as the bird gets older the shades of color of the wild parent become more distinct. The change of form keeps pace with the change of color, which is much more manifest on the hen than on the cock. I have hens now three or

four years old with brown legs, though still showing the pink shade, and on whose feathers the white has very considerably replaced the cinnamon shades. In fact I have many specimens that would readily pass for the bronze domestic turkey, even in the view of an expert. I am satisfied that without a fresh infusion of wild blood, in the course of fifteen or twenty years more but few individuals would show the distinctive marks of the wild turkey to any considerable extent, and the whole would be pronounced the bronze domestic turkey. This change is much more manifest in some individuals than in others, still it is very marked in all. I have met with several farmers in the West who have domesticated the wild turkey and whose experiences correspond with my own, but they are not writing men, though frequently pretty good observers. The truth is that those having the most facts on this particular subject do not appreciate their importance, and the observations they have made are never known to the scientists who are most capable of weighing and comparing them, and it is possible that these have fallen into errors for the want of full data.

The habits of the wild turkey are not as rapidly changed by domestication as its form and coloring; still they undergo a change as well. The wild cock-turkey by the time he is five months old seeks a perch well up in the largest trees in his range, and as he grows older he is constantly inclined to seek a higher perch, till he is frequently found at the very apex of the tallest tree. The largest turkey I ever killed sat at the extreme top of a very tall tree, which enabled me to see him against the background of the clear eastern sky as the day was breaking, while all below was profound darkness, and so I had plenty of time to approach behind another large tree with the most deliberate caution to within range, and there I had to wait a considerable time before I could see the sights of the rifle. He was already alarmed and stood as straight as a penguin, which is the constant habit of the bird when his suspicions are awakened. Fearing he would leave I fired before I could tell whether his back or his breast was towards me. When a twenty-four pound turkey falls from so great a height, and thrashing through the branches of the tree strikes the ground with a great crash, it is music to the ear of him who can claim the prize. A companion once killed a very large cock on the top of a very large tree, under which we had made our camp fire, where he had sat for hours undisturbed by the noise and bustle of our camp. As we had approached

the place without caution, — laughing, talking, and perhaps singing, — he knew he was undiscovered and not likely to be looked for there, and so felt no apprehension, and it was only by an accident that his presence was found out. These incidents tell us of the habits of the bird.

This disposition, especially of the cock, to seek a high perch is scarcely impaired by domestication in the second and third generations, but after that they seem less ambitious for high places, and it appears to grow less and less in succeeding generations, till they come down to about the level of the domestic turkey.

The wild and suspicious timidity so characteristic of the wild turkey is eradicated very slowly. When back in the park foraging they seem suspicious even of the one who daily feeds them, and make off when they see him approaching; but upon their feeding grounds most of them come to pick up the corn even within a few feet of strangers. Let any cause of alarm, however, occur there and they take fright at once. Those only two or three generations from the woods will take wing, while the others will run like race-horses. This wildness, however, diminishes with each succeeding generation.

The eggs of the wild turkey vary much in coloring and somewhat in form, but in general are so like those of the tame turkey, that no one can select one from the other. The ground color is white, over which are scattered reddish-brown specks. These differ in shades of color but much more in numbers. I have seen some on which scarcely any specks could be detected, while others were profusely covered with specks, all laid by the same hen in the same nest. The turkey eggs are more pointed than those of the goose or the barn-yard fowl, and are much smaller in proportion to the size of the bird.

When the wild turkey in the forest voluntarily leaves her nest, she always covers it with leaves sufficient to hide the eggs and all evidence of the nest. This is less carefully done by the first descendants of the wild hen, and each succeeding generation becomes more careless in this regard, till now more than half the nests we find are not covered at all, and none are covered with the care always manifest in the wild state.

This wildness seems the most constant with the hen in the breeding season. When the hens are about to commence laying, they seem to relapse to their native wildness and seek the seclusion of the North and East parks, or if their wings are not clipped they may escape from the park to the neighboring forest and

there rear their young. After these get as large as quails, or perhaps larger, they generally bring them home, or with a little care they may be driven home. Although the young birds are as wild as possible at first, after they have tasted corn a few times and find it is furnished by a man on foot or from a buggy, they lose all fear and become importunate, while the mother hen may still hang back suspiciously. I have often, when driving through the park, had the half-grown birds fly into the covered rockaway for corn, for they soon learned there was always corn there for them.

The cocks after a few generations never get as wild as the hens do at the breeding season, but stay contentedly in the South Park, and nearly always keep together. They may amount to fifteen or twenty in number. If the nest of a hen is broken up she immediately seeks the cocks and then returns to seclusion; and generally she will even make a third nest if the second is destroyed. I have never seen the cocks fight for the hens, although there may be a dozen of them of equal age and size. These seem to have no leader and to have no master, and rarely have disputes except when being fed. Then one is very apt to make a pass at another, which is most likely returned, when two or three others will join in the fray, appearing quite indifferent as to which they hit. After a fracas of two or three minutes they all seem to remember that it is supper time, but on looking about they discover that the hens and the youngsters have taken it all. Whenever the new broods are brought home in the fall, they must be attacked by the home flock, — the old cocks, the barren hens, and the young ones, which have been initiated through similar tribulations. The mother hen is treated as a stranger just as much as if she had never been there before. A single day, however, is sufficient to establish friendly relations, when the newcomers are admitted to the family circle on cordial terms.

I have never noticed any disposition of the old cocks to interfere with a setting hen, or her nest, or her young brood, only when a half-grown flock comes home they are simply treated as strangers, as already stated.

The pinion of a wing has been removed from many of the old hens, and if the latter are kept in the South Park where the cocks run, and which is really the home of all, they nest there, frequently making the nest by a slight excavation in the open grass-plot, away from any protecting object, and one is astonished at the difficulty of finding the hen setting there, although the place

be described where to look. Experience has proved that I do not get nearly as many young from those which are obliged to nest in the South Park as from those which retire to complete seclusion and are never seen or heard of, except by chance, till their chicks are as large as quails.

My observations accord with those of Audubon as to the riendly relations existing between the brood hen-turkeys. It s not uncommon for two or three hens to lay in the same nest, and then set upon the eggs and raise the young together, though this I always look upon as a misfortune, for most likely they will not commence laying together, so that after one commences setting the other will keep on laying for a week or two before she commences setting. As neither will remain a day after the first chick is hatched, of course all the late-laid eggs are lost, unless they are taken out and put under a hen, when they generally hatch out, although they may have lain a day in the nest after they were deserted, if the weather is warm. The hen is often a very pertinacious setter, remaining upon the nest a week or more after all the eggs have been removed. I once found a hen setting upon an empty nest on a declivity of a ravine, and found the eggs scattered about, some very near the foot of the hill, and quite cold, — the mischief of a peacock. Those not broken were returned to the nest. When approached the hen ran away, but soon returned to the nest and hatched out every one of the eggs and raised the birds. The hen, so far as I have observed, never remains upon the nest longer than the morning after the first bird is hatched, though there may be no more than one bird out, leaving all the remaining eggs to their fate. When a day old the chick can follow the hen, though it may tumble down on every foot of the ground it runs over. When two or three days old it will follow the hen with astonishing vigor, and will trail through the grass in a cold rain storm without injury, when similar exposure would have been fatal to the domestic turkey. I have had repeated opportunities to test this, and I do not believe that I ever lost a young bird by reason of its getting wet. Even the hybrids [1] are capable of enduring exposure, when but a few days old, from which we should despair of the domestic bird.

When two young broods meet in the woods neither hen will show hostility to the young of the other, and they will generally separate after a little social intercourse; but sometimes they will

[1] I use this term not in its strict sense, but for convenience.

amalgamate and ever after range together, when each hen will take the same care of all as she did of her own. I have often seen three hens thus together leading around a large flock of young birds, the three broods being manifestly of unequal ages as they were of sizes.

The flesh of the young wild turkey is as white as that of the tame turkey till mid winter. After that it begins to show a darker shade, and when a year old the change of color is very appreciable, and this darker shade deepens till the bird is several years old. All of this is entirely lost by domestication. I have never killed a bird from an egg taken from the wild hen's nest in the woods, for I could not afford to do this, but I have had on my table many of the next generation, all the way from eight months to two or three years old, raised in my grounds. In every instance the flesh was as white as that of the domestic turkey. The change of food and the less active habits produce this change of color of the flesh of the wild turkey.

Turkeys consume more herbaceous food than is generally supposed. In the spring, when fresh vegetation shoots forth, they subsist almost entirely upon it, showing less anxiety for corn than at any other season. Blue-grass and clover they seem to prefer, and on these they graze almost as freely as the geese. Later, when insects appear, they manifest their carnivorous appetite and become constant and diligent foragers for them. They are not scavengers like the barn-yard fowl, but much prefer, if they do not confine themselves to, living animals. Still they by no means limit their selection to insects. I once saw a half-grown turkey acting very strangely, and stopped a little way off to notice his actions. I soon observed that he was in a contest with a snake about ten inches long. He would pick it up and throw it and again seize it as soon as it struck the ground. At length, after the snake seemed pretty well disabled he seized it by the head and began to swallow it. The part of the snake yet in sight thrashed vigorously around, sometimes winding itself around the head and neck of the bird. This was too much for the turkey, and he threw it up and went at it again to make it more quiet, and then another attempt was made to swallow it; but it was not till the third effort was made that success was achieved, and then the process occupied several minutes, the tail of the snake being all the time active till it finally disappeared.

This magnificent game bird was never a native of the Pacific coast. I have at various times sent in all about forty to Califor-

nia, in the hope that it may be acclimatized in the forests. Their numerous enemies have thus far prevented success in this direction, but they have done reasonably well in domestication, and Captain Rodgers, of the United States Coast Survey, has met with remarkable success in hybridizing them with the domestic bronze turkey. Last spring I sent some which were placed on Santa Clara Island, off Santa Barbara. They remained contentedly about the ranch building and, as I am informed, raised three broods of young which are doing well. As there is nothing on the island more dangerous to them than a very small species of fox, we may well hope that they will in a few years stock the whole island, which is many miles in extent. As the island is uninhabited except by the shepherds who tend the immense flocks of sheep there, they will soon revert to the wild state, when I have no doubt they will resume markings as constant as is observed in the wild bird here, but I shall be disappointed if the changed condition of life does not produce a change of color or in the shades of color, which would induce one unacquainted with their history to pronounce them specifically different from their wild ancestors here. Results will be watched with interest.

My experiments in crossing the wild with the tame have been eminently successful. These have been conducted at my farm in the country. I first sent up a cock and turned him out with a few domestic hens. They all raised good broods. The hybrids grew larger than either parent. The next year the hybrid hens, as the breeding time approached, manifested the wild disposition of their wild ancestor, but they had an artificial grove of ten acres a little distance from the buildings, which was set with a thick undergrowth, and here they nested. When they brought off the young broods, instead of keeping about the barns as their tame mothers did, they wandered off through the fields where they found an abundance of insects. There was no forest nearer than two miles, so I think none of them found their way to that. Some of them returned to the grove to roost at night, while others remained away. Pains were taken when they were met with in the fields to drive them to the barn and feed them with corn. This rarely had to be repeated, for they would come up themselves for their suppers. Some wandered away and never returned, but were afterwards recognized about the yards of neighbors perhaps miles away; in subsequent years they were much more easily kept in hand and probably few were lost, till now after seven years there is little trouble to keep them about the

place at night, although they wander off through the fields for a mile or more during the day, but they always get a ration of corn about sunset. Last fall the flock counted one hundred and ten, and was the finest I ever saw together. I have had turkeys on my table the past winter not eight months old that weighed seventeen pounds dressed, though some of the young hens did not exceed nine pounds. I have sent to the farm several thorough-bred cocks at different times, but as they were from my domesticated stock they did not seem to add much to the wildness of the birds.

My experiments establish, first, that the wild turkey may be domesticated and that each succeeding generation bred in domestication loses something of the wild disposition of its ancestors.

Second, that the wild turkey bred in domestication changes its form and the color of its plumage and of its legs, each succeeding generation degenerating more and more from those brilliant colors which are so constant on the wild turkey of the forest, so that it is simply a question of time — and indeed a very short time — when they will lose all of their native wildness and become clothed in all the varied colors of the common domestic turkey; in fact be like our domestic turkey, — yes, be our domestic turkey.

Third, that the wild turkey and the domestic turkey as freely interbreed as either does with its own variety, showing not the least sexual aversion always observed between animals of different species of the same genus, and that the hybrid progeny is as vigorous, as robust, and fertile as was either parent.

It must be already apparent that I, at least, have no doubt that our common domestic turkey is a direct descendant of the wild turkey of our forests, and that therefore there is no specific difference between them. If such marked changes in the wild turkey occur by only ten years of domestication, all directly tending to the form, habits, and colorings of the domestic turkey, — in all things which distinguish the domestic from the wild turkey, — what might we not expect from fifty or a hundred years of domestication? I know that the best ornithological authority at the present time declares them to be of a different species, but I submit that this is a question which should be reconsidered in the light of indisputable facts which were not admitted or established at the time such decision was made.

There has always been diffused among the domestic turkeys of the frontiers more or less of the blood of the wild turkey of the

neighboring forests, and as the wild turkey has been driven back by the settlement of the country, the domestic turkey has gradually lost the markings which told of the presence of the wild, though judicious breeding has preserved and rendered more or less constant some of this evidence in what is called the domestic bronze turkey; and the more these evidences are preserved in the bronze turkey, as the red leg and the tawny shade dashed upon the white terminals of the tail feathers and the tail coverts, the better should the stock be considered, because it is the more like its wild ancestor.

That the domestic turkey in its neighborhood may be descended from or largely interbred with the wild turkey of New Mexico, which in its wild state more resembles the common domestic turkey than our wild turkey does, may unquestionably be true, and it may be also true that the wild turkey there has a large infusion of the tame blood, for it is well known that not only our domestic turkey, but even our barn-yard fowls relapse to the wild state in a single generation when they are reared in the woods and entirely away from the influence of man, gradually assuming uniform and constant colorings. But I will not discuss the question whether the Mexican wild turkey is of a different species from ours or merely a variety of the same species, only with differences in color which have arisen from accidental causes, and certainly I will not question that the Mexican turkey is the parent of many domestic turkeys, but I cannot resist the conclusion that our wild turkey is the progenitor of our domestic turkey. Indeed, we know that this is so to a very large extent, from their constant interbreeding along our frontiers, and I never heard of any one who had wild blood in his flock who did not think he had as good domestic turkeys as any one else.

THE STUDY OF ZOÖLOGY IN GERMANY.

BY CHARLES SEDGWICK MINOT.

I. THE LABORATORIES.

HAVING had somewhat extended opportunities for seeing various laboratories in Germany, and for working in some of them, the writer became much impressed by the great advantages they offer; and as they are at once training-schools and the scene of active original research, it seems appropriate to begin by some account of them.

All the laboratories with which the author is acquainted are connected with universities which, unlike many of our colleges, are not mere high-schools, but are the centres of intellectual activity and the seats of the highest teaching. The distinguishing feature of them is their organization, which gives to original research the highest rewards, and makes everything else subordinate to investigation. Thus, when a student tries for his degree, he passes merely an oral examination, for though he may appear deficient as regards positive knowledge, yet if his thesis contains the results of original work and is judged good, the imperfections of his knowledge are disregarded, and the degree is duly conferred. Again, upon becoming a teacher he is obliged to present another original research, and the professors are, as a rule, selected according to their abilities and success as investigators. The consequence of this system, the same at all the twenty-one German universities, is that both instructors and students regard investigation as the proper scope of their industry. This general spirit makes itself felt in the zoölogical department as well as in every other.

The rigid adherence to this system has made the German universities the home of the highest science. Thus, while intercourse between *savants* is restricted in America and England mainly to accidental meetings and the gatherings of learned societies, the scientists of Germany come together to work for a common end, the maintenance of the university with which they are connected. In every respect science is furthered by the organization and spirit maintained in every German university. There are, of course, grave defects connected with the system, but these the author cannot enter into, not being qualified. These general remarks have been prefixed to indicate that which usually makes the deepest impression on the American student.

The zoölogical department belongs to the philosophical faculty, but the union of the various faculties is very close, and students belonging to one can and habitually do attend the lectures of other departments. Among the zoölogical students it is usual to go through a course of human anatomy and physiology along with the medical students; they are obliged to study two natural sciences besides zoölogy, and to be examined in all three in order to obtain their degrees. In some instances botany is one of the required studies, or when otherwise is usually chosen, and the third subject is commonly chemistry, physics, geology, or mineralogy. Thus it will be seen the students receive a broad scien-

tific training, rendered still more effectual because they voluntarily attend several extra courses.

The quality of the education in each branch depends mainly upon the character and the ability of the professor, and therefore we find the students passing from one university to another in order to attend the courses of some particular professor. This they can do the more readily because immatriculation at one university gives them the right to enter another upon merely presenting their certificates from the first. All the universities are so much alike that it is quite possible to break off from a course at the end of the semester and go elsewhere to complete it. In this way various masters of the same science influence the learners, and the one-sidedness of one teacher is counteracted by another. This seems to the writer an advantage which can hardly be overestimated.

After these brief general remarks we pass to the consideration of the zoölogical work, strictly speaking. First of all we notice the advantage of the secure basis upon which is built up the superstructure of special zoölogical knowledge, thus giving every student an initial advantage which we regret to say is rare in this country.

The professor of zoölogy delivers two regular courses of lectures every year, one semester on general zoölogy or comparative anatomy, and during the second another on special zoölogy, including classification. In the first course he expounds the fundamental characters of animals, their microscopic and comparative anatomy, embryology, physiology, and so forth. This, it will be seen at once, is a different plan from that usually followed in this country, where zoölogical instruction subordinates everything to classification. There can, we think, be no doubt which is the better way. Fortunately, the old system is slowly disappearing in America as well.

Besides the professor there are usually one or two *privat-docents* who, just beginning as instructors, take up some special branch of zoölogy and offer more detailed information than the professor can crowd into his general lectures.

But the main activity of the student is not found in the lecture room but in the laboratory: there he spends most of his time, and there he acquires his most valuable knowledge, learning to dissect and to use the microscope, and making the acquaintance of the principal forms of animal life. The professor and his assistants are constantly at hand to guide and suggest,

and from the very beginning the student is introduced to special memoirs and directed to the best general works. The laboratory is usually provided with a small collection of books, among which never fail to be Gegenbaur's Vergleichende Anatomie, Claus's Handbuch der Zoölogie, Kölliker's Histology and Embryology, and Bronn's Klassen und Ordnungen des Thierreichs. Besides these there are always a number of miscellaneous and more special works — perhaps two or three hundred — whose appearance is that of veterans in service.

The university library, usually very rich in old publications, but apt to lack many of the newer ones, is accessible to the students, though getting out a book involves usually great and, as the experience of our American libraries prove, unnecessary annoyance. There is generally no catalogue to which the students are allowed free access. Altogether, Americans sometimes justly feel provoked by the clumsiness of the arrangements in the libraries, — the usefulness of which certainly does not correspond to the number of volumes they contain, — but after all the books are there and can be got at. The writer has always found his professors exceedingly kind in lending books, and that is of great advantage, because, thanks to the admirable practice of interchanging scientific publications so extensively, all the leading men own separate reprints (*separat-abdrücke*) of a great many papers.

The laboratory is always connected with a museum, which, except at Berlin, Munich, or Leipzig, is small, having been created mainly to bring together an instructive collection, sufficient to exhibit the principal varieties of animal forms, and to supply the necessary anatomical preparations for illustrating the lectures and aiding the students. Besides this it is often attempted to keep up an abundant supply of specimens for dissection. The students are encouraged to collect living specimens for themselves, and to learn to recognize the typical forms of animals. The writer has often seen a professor bring in some strange creature and make the learners examine it, and try to determine its relationship for themselves.

Having looked at the conditions under which the learner is placed, we proceed to examine his work. We notice above all a want of system: each person is launched out by the instructor, but has afterward to guide himself as best he may, with occasional help or warning from his teachers. It strikes one as a rather slipshod manner of learning, but it is pretty sure to weed

out the inferior pupils, for only industrious and energetic ones can struggle on to the end. The woful lack of method would be more injurious than it is, were it not counteracted in every laboratory by the spirit of truth-seeking, which should always guide every original investigation, and by the rivalry among the students, and the high respect for zoölogical science constantly inculcated.

The first thing learnt is the distinction between physiology and morphology as the two great branches of zoölogy, and then most of the time is taken up with morphological work; consequently morphology comes to be viewed as the principal field of work for a scientific zoölogist. Classification, comparative anatomy, histology, and embryology are combined as one department, and the aim of the student becomes finally to make himself acquainted with the general principles of morphology, with the intention of ultimately taking up some special investigation. In America a class or an order are made a specialty, and we have carcinologists, herpetologists, ornithologists, etc., who attempt to study everything connected with the group they have chosen. In Germany some branch of morphology is taken up, thus the eye, or the nervous system, or the comparative anatomy of some division. In one country all the characters of one group are made a specialty; in the other more frequently a few characters are studied in many groups.

When the student has advanced far enough, he is encouraged to take up some special investigation with a view to writing his thesis to get his degree. The foundation having been broadly and well laid, he narrows his attention to a particular question and begins his original work. It is then that the professor becomes most ready to assist, and it is generally considered his most important function to teach how to make a research by carefully controlling and guiding the learner in his first research, examining his preparations and discussing his conclusions with him. This is admirably done by some professors, poorly by others, but all are interested in its being well done, because a fault in a thesis by a pupil from a laboratory discredits the professor who ought to have cared for its avoidance. Many graduating theses are valuable papers, often quoted as scientific authorities upon the subjects of which they treat. Their character generally shows the ability of the student pretty fairly, whether he be equal to difficult problems or only to simpler ones.

In Germany special knowledge is required on the part of the teachers; it is only in the United States that a professor has to teach zoölogy, botany, palæontology, and geology all at once. Accordingly there are often persons in the zoölogical laboratories who intend to become school-teachers, while the more brilliantly endowed aspire to university chairs. There are then two sorts of students, but though the aim of one is humbler, yet they too prize the degree of Doctor and work eagerly at their theses to secure the desired title. The opportunity is thus offered to each student to follow the course of several investigations.

The research is usually upon some point in comparative anatomy or in embryology, less frequently in histology, but it seldom has much to do with species, which are our greatest bugbear. New species are seldom discovered in Europe now, unless among the worms and protozoa, but anybody can find new species in the United States in almost any group of invertebrates. An industrious collector could probably easily obtain in one year in New England alone more than one thousand undescribed species of hexapod insects. In fact the trouble in Europe comes not from the species having no name, but from their having half a dozen different names. However, the forms are almost all known, and the work of zoölogists is much eased by it. It is to be hoped that we shall soon be equally well off.

In every laboratory microscopes are in continual use. The instruments are always simple and small, being intended to be kept on the work-table, and take up little room. The complicated machines, the delight of amateurs and the abhorrence of histologists, so much in vogue among us are never met with there. It is common enough to find Americans and Englishmen giving up their big home-made instruments and taking to the smaller and more convenient Continental microscopes, but the writer never knew any one to do the reverse. Simplicity, efficiency, and inexpensiveness make the German and French microscopes so superior to ours that it becomes a waste of money to purchase an American instrument.

Not only does the student keep his microscope constantly in use, but he is also continually making histological preparations of whatever good material he gets. He therefore becomes skilled and experienced, sees a great many different tissues, and is enabled afterwards to examine the cellular structure of any organ he wishes to study and control his results by comparisons with the tissues which he has already studied. Our next article will be

on the methods used for making histological and embryological preparations. The account here given applies, of course, to the best laboratories, but they do not all offer the same great advantages.

THE DISTRIBUTION OF VEGETATION IN PORTIONS OF NEVADA AND ARIZONA.*

BY W. J. HOFFMAN, M. D.

THE flora of Nevada may be divided into four distinct classes, namely: —

I. The flora of the mountains.

II. The flora of the foot-hills.

III. The flora of the plains.

IV. The flora of the salt marshes.

In the lower two thirds of Nevada and the northwestern portion of Arizona, from latitude 41° 40′ N., at Bull Run Mountain, southward to latitude 35° 20′ N., we have a country composed of a series of plains and deserts surrounded by a net-work of mountain chains. The more northern valleys are composed of tolerably good soil, but as we proceed southward they become more and more sandy, and contain a greater amount of saline ingredients. There is every evidence that many of these basins were at one time inland seas, but owing to the rapid evaporation and absence of aqueous precipitation, they have in the greater number of instances become dry, leaving their solid ingredients as the soil of the deserts, as in Diamond Valley, Death Valley, etc., or there may still remain sufficient moisture to cause salt marshes, as Armagosa Desert and that at Silver Peak which covers an area of only about eight or nine hundred square miles of mud and salt. A great deal of the alkalinity of some regions is derived from the mountains. During the disintegration of feldspathic rocks, the soluble salts are slowly carried down to add to the sterility of the valleys. Rain seldom falls on the plains, but the more prominent peaks are subject to showers nearly every afternoon. Peaks whose altitude exceeds that of the timber-line are most frequently visited. The causes are, the air becoming heated on the deserts (as in Death Valley we recorded 120° in the shade at from two to half past three o'clock) rises towards the cooler summits of the mountains, when condensation of vapor terminates in precipitation, the heavy clouds charged with electricity hanging over the mountains for an hour or two, usually

disappearing before sunset. The rain seldom reaches the base, as the parched sandy soil absorbs it before it descends half-way down to the foot-hills, except in case of cloud-bursts when the water tears up a new channel and rushes out over the desert to sink at once in the soil. These storms do not affect the atmosphere of the plains perceptibly. Differences of wet and dry bulb readings show variations ranging from 5° to 45° F.

The flora of that portion of Arizona under consideration may likewise be classed under the same divisions, excepting that the fourth class gradually diminishes, giving place to that of the dry sandy deserts — which we will include with the third class — of the plains in Nevada.

The following table is arranged according to the latitudes, commencing at the northernmost point (Bull Run Mountain) and running south: —

Name.	Altitude above Sea Level.	Elevation of Timber Line.	Latitude.	Elevation of Nearest Plains.
Bull Run Mountain.......	8,450	8,300	41° 40′	5,800
Prospect Hill............	9,650	9,400	39° 30′	6,000
Belmont................	12,000	9,700	38° 40′	7,000
Mt. Nagle...............	11,000	11,000[1]	37° 46′	7,200
Mt. Macgruder...........	11,500	11,150	37° 40′	7,200
San Francisco Mountain..	13,500	{ 12,500 13,000[2]	35° 19′	{ 6,500 6,800
Bill Williams Mountain...	10,030	[3]	35° 13′	6,500

Mr. J. M. Coulter,[4] in his report upon the flora of Colorado, etc., says "that there is a very regular increase in the elevation of the timber-line as the latitude decreases, subject, of course, to variations when in the neighborhood of high table-lands or seas." This not only holds true in that region between the Rocky Mountains and the Sierra Nevadas, but, in taking a view of the section from Bull Run to Mt. Macgruder in Nevada, and as far as Bill Williams Mountain in Arizona, we have a barometric profile upon which not only the timber-line follows that law, but likewise different genera of plants and trees. The level of the prairie at Bull Run is 5800 feet above the sea, while at Mt. Macgruder — the southernmost point of observation in Nevada — it has risen to 7200 feet. At Bull Run the timber-line, at an altitude of 8300 feet, terminates with the upper line of the belt

[1] The altitude of Mt. Nagle does not reach that of the timber-line.

[2] The timber-line on this mountain is irregular, approaching to within one thousand feet on the eastern side and five hundred feet on the western.

[3] Bill Williams Mountain does not reach the elevation of the timber-line.

[4] Prof. F. V. Hayden's Report, 1872, page 751.

of *Coniferæ*, while the lower line rests upon a belt (400 feet of the vertical section) of mountain mahogany (*Cerocarpus ledifolius*), which in turn gives place at 7000 feet to the belt of *Salicaceæ*. This group terminates irregularly at the beginning of the foot-hills, at an elevation of about 6200 feet. The foot-hills are chiefly covered with *Phlox*, *Lupinus*, and *Rosaceæ*, and the plain with "grease-wood" (*Sarcobatus vermiculatus*) and "sage-brush" (*Artemisia tridentata*), the former being greatly in excess, but is gradually replaced by the latter going southward. The lines of demarcation are frequently indistinct, owing to the mingling of species of one belt with the adjoining ones, but they are plain enough to obtain an average elevation which I shall adopt in these descriptions.

At Prospect Hill, the timber-line has risen to 9400 feet in altitude; the belt of mountain mahogany becomes narrower, giving place at 8000 feet to the *Salicaceæ*, which belt becomes broader and terminates below at an elevation of 7000 feet. As the level of the plain is 6000 above the sea, there are 1000 feet to be accounted for. The plain contains more *Artemisia tridentata*, and *A. filifolia* in place of *Sarcobatus vermiculatus* to a very great extent, the latter being found on the lower foot-hills, above which we find but little *Phlox*, some *Lupinus*, and more *Rosaceæ* and *Compositæ*. There is here a great increase in elevation of similar species over those at Bull Run.

Again, at Belmont the *Coniferæ* end with the timber-line at 9700 feet, and where the belt of the *Salicaceæ* begins but a seam of scattering mahoganies is found, the place having been taken up by a wider belt of *Coniferæ* above and of *Salicaceæ* below. On the plains south of Belmont more saline matter is found in the soil, giving rise gradually to a more desert-like vegetation. *Artemisiæ* are less numerous, and are replaced by *Algarobia glandulosa*, the former occurring abundantly on the foot-hills, upon the upper slopes of which *Cactaceæ* now make their appearance. At Mt. Nagle and, just south of it, at Mt. Macgruder, there is little variation of elevation of the flora, so that at the latter the timber ceases to grow at 11,150 feet (covering the summit of Mt. Nagle at an altitude of 11,000 feet), the belt of *Coniferæ* running down to 8500 feet, when the belt of *Salicaceæ* occupies the space down to an elevation of 8100 feet above the sea. The belt of the *Compositæ* now rests upon one of *Yucca buccata* and *Y. angustifolia*, which, farther down on the foot-hills, is replaced by *Cactaceæ*, and on the desert by the *Artemisia triden-*

tata and *Algarobia glandulosa* in excess. The plains and salt marshes in this vicinity are at an elevation of 7200 feet above the sea, and gradually slope towards the Colorado River, until we reach the deserts just north of that valley, where the average elevation is 1400 feet. This descent is so rapid, comparatively, that as we proceed southward, zones or belts of vegetation are passed through — underlying that upon the salt deserts at Macgruder — not encountered heretofore, and which partake of a sub-tropical nature in predominating species, that is, *Cactaceæ*, such as *Echinocactus*, *Mamillaria*, *Agava*, and *Larrea Mexicana*.

Southward and eastward of the Colorado River, in following this elevated portion of the country, we encounter the Colorado Plateau, having an elevation of from 6000 to 6700 feet. Upon this we have San Francisco Mountain and Mt. Bill Williams. Upon the former, the timber-line rises to within one thousand feet of the summit upon the eastern side (12,500 feet) and to within five hundred on the western (13,000 feet).

The belt of *Coniferæ* extends down to the base of this mountain as well as on Mt. Bill Williams,[1] and is subdivided into two divisions, the upper being composed chiefly of *Pinus brachyptera* and *P. edulis* Engelm., and the lower of *Abies Douglasii* and *Juniperus occidentalis*. Throughout the ravines and moist depressions we now find *Fraxinus velutinus* common, and scarcely any *Populus monilifera*. Around the base of both mountains we find *Quercus Gambelii* extending up the eastern slopes but *not* upon the western.

After leaving the plateau, going southward, and again descending to an elevation of 3500 feet, we meet the belts of sub-tropical species which occur above the plateau (in Southern Nevada) at a corresponding place, allowing the increase of elevation which it gains in this distance proportionately.

As we descend toward the valley of the Rio Gila, *Cactaceæ* predominate, nine species having been identified, not embracing varieties which are undoubtedly present and which could have been detected upon closer examination. Farther west, including the Mojave Desert, and northward as far as Vegas Valley, we find this thorny vegetation to a great extent; and in various depressions and ravines occur *Eriodiction*, *Algarobia*, and *Prosopis*.

There is a gradual elevation, as we proceed southward, of all these zones or belts of vegetation, which may at times consist

[1] For information regarding San Francisco Mountain I am indebted to Mr. G. K. Gilbert (Geologist Geolog. and Geograph. Exp. for Explor. Nevada and Arizona, 1871–2, Lt. G. M. Wheeler, Corps of Engineers, commanding).

only of a single species (*Cerocarpus ledifolius*), at others of a genus (*Pinus*), but more frequently of a variety of genera or even of families. In the northern portion of Nevada a single genus of plants is often found occupying a large extent of rolling country, when, as we reach the limit of distribution, a few yards farther on will find us in another and a distinct group. At some points, again, the line of demarcation between the desert flora (*Artemisia tridentata*) and that of the foot-hills (*Sarcobatus vermiculatus*) is so sharply drawn as to be visible from any elevated point of observation, this being apparent on account of the difference of the color of foliage.

Again, we find areas over which the vegetation is as yet an indiscriminate mingling of genera and families, but over which the *Compositæ* appear to have the "balance of power."

This peculiar distribution is apparent over all that portion of Nevada and Arizona before named, but as we go southward we find each genus or family of plants or trees gradually rising in elevation, and if we do not discover all the preceding individuals, we find representatives belonging to the same genera or families replacing them at those altitudes, which in turn give rise to other forms, to other types, or a new belt, occupying that space caused by the elevation of the belt above. This succession is visible in following the elevated mountain regions of the American continent, but is modified in the vicinity of seas, as at Panama. As the vegetation is thickest and most luxuriant in the tropics, it forms a covering which decreases in quantity and growth towards either pole. The equatorial zone is the home of ferns and palms, which gradually lose predominance in advancing towards the temperate zones as they do in ascending the mountains situated in the equatorial regions. That at great altitudes the belts of vegetation and timber are again met with, which as cend from both the northern and southern parallels of latitude, is verified by Von Humboldt,[1] who says, "The great elevation attained in several tropical countries, not only by single mountains but even extensive districts, enables the inhabitants of the torrid zone to behold also those vegetable forms which, demanding a cooler temperature, would seem to belong to other zones. Elevation above the level of the sea gives this cooler temperature even in the hottest parts of the earth, and cypresses, pines, oaks, berberries, and alders nearly allied to our own cover the mount-

[1] Aspects of Nature, etc., Alex. von Humboldt. Trans. by Mrs. Sabine, Philadelphia, 1849, pages 245, 246.

ainous districts and elevated plains of Southern Mexico and the chain of the Andes at the equator."

This rule is also followed by representative species of birds, taking, for example, the ruby-throated humming-bird (*Trochilus colubris* Linn.), which is found from latitude 61° N. to Terra del Fuego, the southern remnant of the American continent, while it has been observed in the tropics at an altitude of 14,600 feet. I have observed it in Nevada, latitude 38° N., at an elevation of 9700 feet (timber-line), and it appears thus to be found nearly everywhere within that line, at which phenogamous vegetation ceases to exist.

Species found in Mexico are also found at an altitude in the tropics at which the same temperature and the same belt of vegetation occurs, which would place an outside limit of altitude at about 10,000 feet. M. Becquerel[1] says, "In the equatorial zone no change is observed in the vegetation from the level of the sea to the height of 600 metres (1969 feet), and beyond this even to an altitude of 1200 metres (3937 feet) we still recognize the flora of the tropical zone."

It is apparent, then, that in the distribution of a flora from north to south, or in equal directions (or nearly so) from the equator, there is a downward tendency as the latitude increases. This zone of vegetation being divided into successive layers, vertically at the torrid zone, which, as they rise in altitude, spread their termini over a section of country where they descend, give rise to a succession of changes from a torrid to an arctic flora. This zone forms an arch, when viewed in a barometric profile, from the northern to the southern hemisphere, having the greatest depression over the equatorial region.

That the regularity in location of these various belts is governed by climatic or meteorological laws, modified to some extent by geological causes, is apparent and undoubtedly true, but regarding the local distribution throughout any one of these belts there are slow changes, as on some of the deserts in Arizona or in the salt marshes of Nevada.

On the Gila Desert, as elsewhere, we observed the remains of an undergrowth of acacias (*Algarobia glandulosa*) which were destroyed by the encroaching *Cereus giganteus*, and here the law of *mutual repulsion* is forcibly illustrated. Dr. J. M. Bigelow[2] noticed the same fact in the valley of Bill Williams Fork, and

[1] In Smithsonian Report, 1869, page 401. (Translation.)

[2] Pacific R. R. Report, vol. iv., page 21. (No. 2 Botany.)

says "that it [Acacia] forms a shelter for the propagation of the *Cereus giganteus* of that region. Every young *Cereus* is protected and fostered by this tree until the cactus attains the size and hardihood that enables it to withstand the war of elements waged against it, when it ungraciously spurns its protector, ultimately destroying it, as we saw in numerous instances on our journey."

That geological and climatic influences and effects modify and in time alter the flora of a district is perceptible in the salt marshes. Here the lower forms of vegetation flourish in luxuriance, especially the *Chenopodiaceæ*, in which the higher types seem unable to exist on account of the strongly alkaline soil, and even in waters strongly impregnated with salt, forms exist which retain these places in spite of the force brought to bear upon them from the invading species which perish not from a "mutual repulsion and subjection," but from the alkalinity of the soil itself.

Mr. Lester F. Ward proposes "what might be called the law of *mutual repulsion*, by which every individual, to the extent of its influence, repels the approach of every other and seeks the sole possession and enjoyment of the inorganic conditions surrounding it; this mutual repulsion results at length in a statical condition which is always brought about through the action of the vital forces themselves, and which, as soon as reached, determines absolutely the exact place and degree of development of each species and each individual."

This is at present not the case in the salt marshes, but, when an accumulation of organic and silicious matter is the result, through the decomposition of the plants and the dust from surrounding sources, these lower types lose their predominance, and higher types replace them. This will ultimately be the result, as there is no aqueous precipitation, and the constant evaporation from the marshes will leave them nothing but alkaline deserts.

Upon the foot-hills in the upper portion of Nevada different species of plants occupy distinct patches, but it is apparent that there are changes going on, and that in time some will be destroyed, giving place for hardier varieties. Mr. Ward further says, "Each species is the perpetual and inexorable antagonist of every other. The 'struggle' is not alone 'for existence,' it is also for *space*. . . . . But the first principle, as in the rest of nature, is force. Each one encroaches with all the power of

vegetal growth upon its neighbors." Where an area of vegetation has not been disturbed by mechanical or agricultural causes, the species and genera growing thereon are to all appearances occupying their limit of growth and local distribution, as over various valleys and low elevations in Northern Nevada. "But let these statical conditions be once changed, ... and this equilibrium is immediately disturbed. The chained forces are set free; a general swarming begins; some individuals are destroyed, others are liberated; each pushes its advantage to the utmost, and all move forward in the direction of least resistance, till at length they again mutually neutralize each other, and again come under new conditions and modified forms, into the former state of quiescence." [1]

There has been great difficulty experienced in some of the fertile valleys of Nevada and California in attempting to prevent the rapid encroachment of native plants upon partially cultivated and irrigated patches of soil. They are stronger in vegetal power, and in a short time depauperate and stunt the introduced cereals and garden vegetables.

These vegetal "struggles for space and existence" are stronger and the results more perceptible in the tropics than elsewhere; rising in altitude with the superlying belts of vegetation, they decrease until the region beyond the timber-line is reached, in a similar manner as when we proceed towards either pole in almost a fixed proportion to the latitude. This is caused by a variety of influences, prominent amongst which are

(1.) The presence of saline matter to such an extent as to cause the destruction of any but the lower types of. vegetable life, — *Chenopodiaceæ.*

(2.) In the sub-alpine belt or latitudes, where the *Coniferæ* predominate and where there is a corresponding temperature unfavorable to other types generally, and

(3.) Beyond the timber-line or at extremely high latitudes, where the superincumbent mass of snow in winter and the extremely short temperate season prevent the growth of almost anything save lichens and mosses.

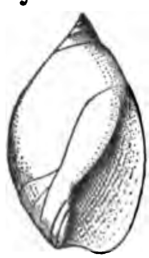
[1] Mr. L. F. Ward, Popular Science Monthly, October, 1876.

ABORIGINAL SHELL MONEY.

BY ROBERT E. C. STEARNS.

IN several articles heretofore published,[1] I have written on the use of various species of shells for the purposes of money by the aborigines of North America, and have also briefly referred to the use of the same class of material for similar purposes in Africa and India, and the antiquity of shell money in the latter country.

Since the date of my last paper additional data have been acquired, which are worthy of note as they relate to certain West American species of mollusks not before enumerated, the shells of which have been and to some extent are still used for money by some of the Indian tribes in California.



(Fig 62.) OLIVELLA BIPLICATA Sby.

The discovery of a species of Olivella (*O. biplicata* Sby.) in ancient graves on San Miguel Island (one of a cluster of islands thirty miles westerly) off the southerly coast of this State was referred to in a previous paper. I have since examined specimens of the same species, found by Mr. C. D. Voy in a burial mound near Vallejo, in Solano County, in the year 1872, now in the museum of the University of California, which also contains much rare and interesting prehistoric material collected by the same person in various parts of the State. Of this species about two hundred specimens were obtained from the Vallejo mound, as well as human remains and numerous aboriginal relics, such as stone pipes, bone whistles, and arrowheads, also another form of shell money and ornament described further on.

In all of the Olivellas from the Vallejo mound, the upper part of the spire or the apex of each shell has been ground off in the same manner as in the San Miguel Island specimens,[2] and it is presumed that they were formerly strung and worn as a necklace, an ornament for which these shells are still used by some of the interior Indians of Central California, as I have been informed by Mr. Stephen Powers, a most excellent authority. He says that this form is now used for personal adornment by the Bear River Indians, and is by them called "colcol." Referring to the shells he writes, "They are strung double, that is, two strings of them

[1] American Naturalist, March, 1869; Overland Monthly, April, 1873; Proceedings of the California Academy of Sciences, July, 1873.

[2] Collected by Mr. W. G. W. Harford.

are tied together between each two shells, so that the shells are mouth to mouth. But even this double string is lightly esteemed, being worth only one dollar a yard. It is little used for money, being rarely seen at all, and is worn chiefly by the women in dances as a cheap jewelry."


(Fig. 63.) COLCOL.

The specimens kindly sent to me by Mr. Powers are of the white variety, which are much less abundant than those of the usual bluish tinge; neither are these nor any of the grave specimens above a medium size, for this species frequently attains a length of an inch and a quarter, as may be seen in Figure 62. The Vallejo mound specimens average only half an inch, which fact suggests that the smaller size may have been more highly valued.

It will be observed that the Olivellas, or colcol, have been found in ancient graves on San Miguel Island associated with human remains and prehistoric implements, also by Mr. Voy in Solano County, and Mr. Yates in a recent article reports their occurrence in the mounds of Contra Costa and Alameda counties.

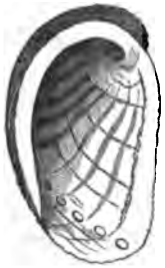
By reference to a map of California it will be seen that these last localities are widely separated from the first named, and it implies not only the general use of this species of shell by the maritime tribes, but also a line of intercourse and a system of traffic between the coast tribes and those of the interior, as suggested in a previous paper, and through which the colcol finally came to be used by the Indians of the central part of the State.

In my first paper,[1] alluding to the use of *Saxidomus gracilis*, a common bivalve on the coast of Sonoma County, I expressed surprise that the equally common and far more beautiful shells of *Haliotis rufescens* had not attracted the attention of the aborigines, and been utilized by them for money and personal decoration. It will be seen, however, that the beauty of these has not escaped the eye of the savage, but that they have been used both for money and for personal decoration, and been fashioned into a variety of shapes for the latter purpose, the prototypes of the "abalone jewelry" so popular with the "pale-faces" of to-day.

From the Vallejo mound Mr. Voy obtained various pieces of Haliotis, or abalone, as the Californians call it, which is the *aulon* or *aulone* of the Spanish, and the *uhllo* of the Indians. In reference to the Indian name Mr. Powers writes: "Your conjecture

[1] American Naturalist, March, 1869.

that the word *uhllo* is corrupted from the Spanish *aulon* is probable, although the Indians accent the first syllable, giving it a sound difficult for us to imitate, somewhere between *uh* and the German *ö*."



(FIG. 64.) HALIOTIS OR ABALONE.

The accompanying illustrations represent the specimens taken from the Vallejo mound in the year 1872, with which, as before stated, were found human remains and numerous aboriginal relics. They form a part of the Voy collection presented to the University of California by Mr. D. O. Mills, of San Francisco.

These ornaments and this money, if we may consider the circular pieces as the latter, are all made from the same species of Haliotis (*H. rufescens* Swainson), the common red-backed abalone of the coast, which has a range of nearly the entire shore line of the State; and a large species which sometimes attains a length of eleven inches.

In Figure 2 of Plate II. we have an approximately circular disk; Figure 1 in the same plate may have been nearly the shape of 2, and have become partially disintegrated and scaled or flaked off, since it was buried, through oxidation and decay. The dark patches on these figures represent the red exterior of the shell from which they were made, and which still remains on the specimens. Figure 3 is well worked out, a nearly perfect circle with the edges neatly serrated or toothed, as if done with a sharp piece of obsidian, while Figure 4, though without apparent design, has been rubbed or rounded so as to make the edges smooth, as have also the pieces figured in 1 and 2, and the holes have been carefully perforated. Figure 4 shows the mark where a hole was started and not completed, probably from its being too near the edge.

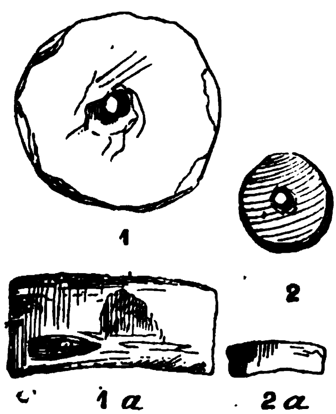
Over a dozen of these disk-shaped pieces, including those figured, were found by Mr. Voy, and Mr. Yates also records approximately similar forms of smaller size, though he does not state the species of Haliotis from which his specimens were made. Mr. Henry Edwards, the entomologist, has also obtained this abalone money from the kitchen-middens of Marin County, near Saucelito.

Mr. Powers, referring to the use of Haliotis, says, "The uhllo pieces are of a uniform size on the same string; they do not mix them. The dollar pieces (Plate II., Figure 5) are generally about one and one quarter inches long and an inch wide; the smaller about as long but narrower; . . . a couple of fragments

I picked up in an old Indian camp (Plate II., Figures 6 and 7) are worth twenty-five cents each. The Indians are very ingenious and economical in working up the aulones: wherever there is a broad, flat space they take out a dollar piece; where the curve is sharper, smaller ones. They especially value the outer edge [1] of the whorl or lip, where the color is brilliant, and these they are obliged to cut into twenty-five cent pieces. You will see that the uhllo is cut into pieces of different sizes, and even pieces of the same size vary in value according to their brilliancy. . . . All the money that I have seen was strung on grocery twine, but they often use sinew of various kinds, also the outer bark of a weed called milkweed [2] about here." [3]

The uhllo necklace has three or four strings of very small glass beads above the shells, forming a band about one quarter of an inch wide, which encircles the neck. . . . A common deep conical basket, of about a bushel and a half capacity, such as the squaws use for carrying their household effects, is worth one and one half or two strings of uhllo, that is, fifteen or twenty dollars.

Another form of money is made from the heavy shells of a bivalve, a ponderous clam (*Pachydesma crassatelloides*) peculiar to the southern coast of California. This is cut into circular pieces of the diameter as shown in the annexed figure (65), the thickness of the pieces varying with the thickness of the shells from which they are made. The larger pieces (Figure 65, 1 and 1 *a*), of the value of twenty-five cents, are cut from the thicker parts of the valves, and the smaller (Figure 65, 2, 2 *a*), of the value of four cents each, from the thinner portions. This money, of which the smaller pieces closely resemble the disk-shaped beads of the natives of the Paumotu Islands in the South Pacific,[4] except in being of twice the diameter and thick-



(FIG. 65.) HAWOCK.

[1] Columella. [2] Asclepias. [3] Placer County, Cal.

[4] The Paumotus are in about longitude 130° W. and latitude 23° S. The pieces made by these islanders are of about one half the diameter and one half the thickness of Figure 5; they are made of *Oliva carneola*, and it must require great labor, as these transverse sections are formed by grinding off the small upper whorls of the apex, and also nearly the entire body whorl, until a disk is obtained of an average thickness of only one twelfth of an inch; these are strung alternately with thinner disks of the same diameter, made of the inner hard shell of the cocoanut, forming a neat necklace, with a pleasing contrast of black and white.

ness, is strung upon strings the same as beads in a necklace, for which purpose it is also used. Figure 5 is the same in form and of about the size of the pieces made from *Saxidomus gracilis* (*S. aratus*), according to Yates, and in use "among the Indians of Lake County. Eighty of these disks are valued at one dollar."

This money, which is called *hawock*, according to Mr. Powers, is universal throughout Middle and Southern California, though different tribes call it by different names and attach different values to it.

"Sometimes disks of hawock are made two inches in diameter and half an inch thick, which are rated at one dollar a piece, but such large pieces are seldom seen."

"The Bear River Indians (Neeshenams) are the only ones I have seen who count it by the single piece, the others rate it by the foot or yard. . . . It is sometimes strung upon a string many yards long, in hundreds of pieces, and doubled into lengths of about a yard. The Wi-Lackees make the buttons thin, then every tenth one thicker, so that it looks like a Catholic rosary, and their name for it is *tocalli*."

In a photograph of a young woman of the Bear River Indians, named Válputteh, received from Mr. Powers, her person is adorned with a necklace of hawock which, it is stated, is ten yards long, requiring to be wound several times about her neck, and consisting of about 1160 pieces, valued at $232. Another of the same tribe, Pedah or Captain Tom, has an inventory of money and ornaments made of the uhllo (Haliotis), hawock (Pachydesma), and colcol (Olivella), of the total value of $479. The uhllo, however, seems to be the most highly prized, and in various ways is wrought into gorgets, girdles, and head-dresses, as the hawock and colcol is principally used for necklaces. Gorgets of Haliotis are especially valued, as they require a large and fine shell for this purpose.

Upon reviewing the present and my previous papers, it will be observed that the species of shells named in the following table have been or are now used as money by barbarous tribes on this continent and in other parts of the world.

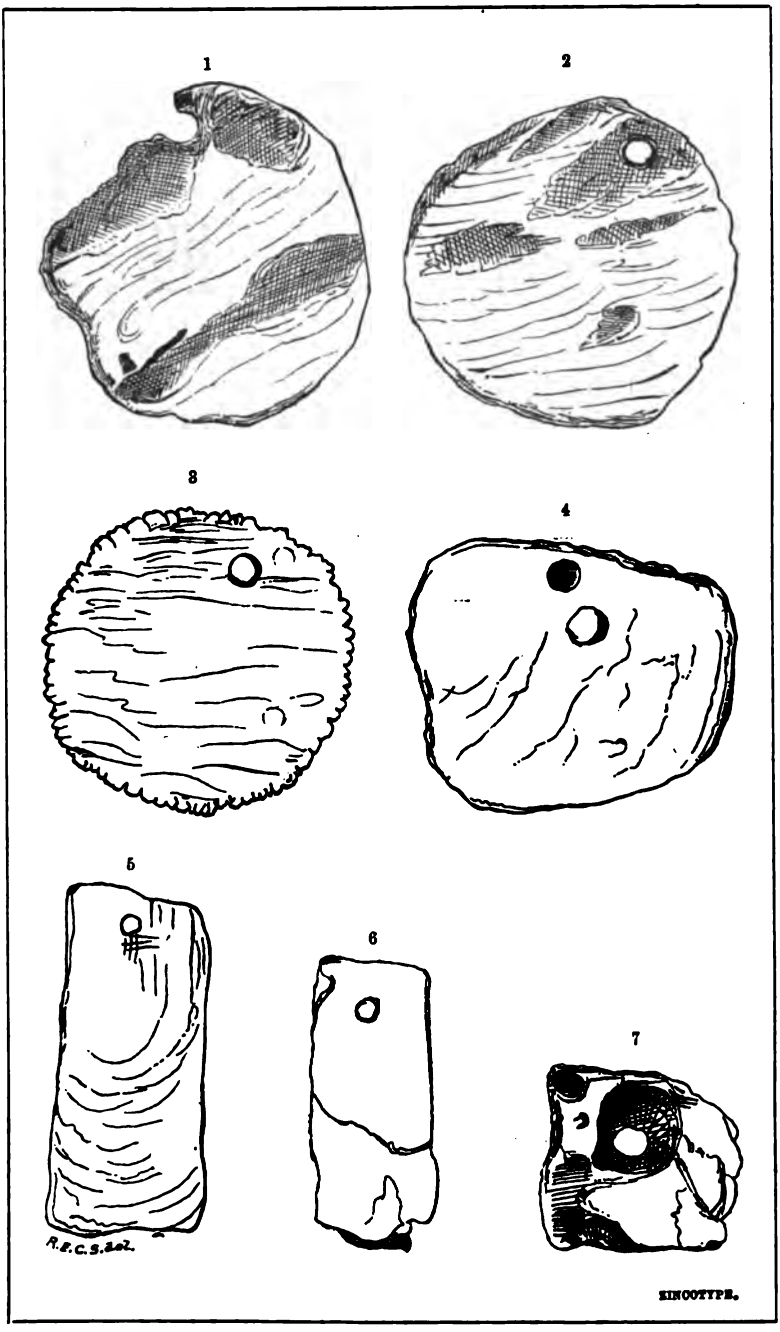


PLATE II. ABORIGINAL SHELL MONEY.

NORTH AMERICA.—West Coast.

Scientific Name.	Popular Name.	Aboriginal Name of Shell.	Aboriginal Name of Money.
Dentalium Indianorum Cpr. = D pretiosum Sby	Tusk or Tooth Shells	Alli-co-chick or Alli-co-cheek of California Indians	
Dentalium entalis L.*	Tusk or Tooth Shells		Hi-qua or Hy-a-qua of Alaskan tribes.
Olivella biplicata Sby	Periwinkle	Used by California Indians	Col-col.
Haliotis rufescens Swainson	Abalone, Aulon, or Aulone	Used by California Indians	Uhl-lo.
Fissurella (Lucapina) crenulata Sby	Keyhole limpet	Used by California Indians	Unknown.
Saxidomus aratus Gld. = S. gracilis Gld	Clam	Used by California Indians	Unknown.
Pachydesma crassatelloides Conr	Clam	Used by California Indians	Hawock and Tocalli.

NORTH AMERICA.—East Coast.

Scientific Name.	Popular Name.	Aboriginal Name of Shell.	Aboriginal Name of Money.
Venus mercenaria L. = Mercenaria violacea Schum	Hard Shell Clam or Quahaug	Poquahauges or Poquahock	Black Wampum or Wampampeege.
Pyrula (Busycon) carica L.	Whelk	Metanhock	White Wampum or Suckanhock.
Pyrula (Busycon) canaliculatum L.	Whelk	Metanhock	White Wampum or Suckanhock.
Buccinum undatum L.	Whelk	Metanhock	White Wampum or Suckanhock.

INDO-PACIFIC AND AFRICAN REGIONS.

Scientific Name.	Popular Name.	Aboriginal Name of Shell.	Aboriginal Name of Money.
Cypræa moneta L.†	Guinea money and Prop Shell	Unknown	Unknown.
Cypræa annulus, L.‡	Ringed cowry	Unknown	Unknown.
Littorina obesa Sby	Unknown	Unknown	Unknown.
Nerita polita L. (banded var.)	Unknown	Unknown	Unknown.
Unknown species	Used in Soudan	Oudâas or Woodahs	Unknown.

* Imported from Europe for the Indian traffic, by the fur-traders of the North.

† Imported by the Europeans from the Maldive Islands, for the African trade. Also in use in India in the sixth and seventh centuries, and since.

‡ Found by Layard, in the ruins of Nimroud.

GAMING AMONG THE UTAH INDIANS.

BY EDWIN A. BARBER.

IN their indolent hours, gaming and horse-racing are extensively resorted to by the nomadic tribes of America. Having much unoccupied time on their hands, they turn to these exciting amusements as a relief from the consuming *ennui* of idleness.

During the summer of 1874, I had some opportunities for studying the habits of the Yampa branch of the Utah nation, located in the northwestern corner of Colorado. In strolling through their encampment, one was always attracted to several of the more prominent *wick-e-ups*, or canvas lodges, by the sound of subdued music, and on entering either of the tents, the visitor was rewarded for his trouble by the sight of several warriors engaged in gambling. So great, indeed, is their earnestness when engaged in this pastime that they do not observe the arrival of strangers, and as they progress they become so deeply absorbed in the exciting reverses of the game that they can only be awakened to a consciousness of surrounding objects by the greatest exertion. They may commence by putting up small articles of apparel or ornament, such as moccasins, necklaces, or strings of beads. Should these be lost, blankets, powder, lead, caps, flour, the highly prized wampum, and other miscellaneous articles will be staked, and the unfortunate loser not infrequently comes out of the play-room without an object in the world that he can call his own or his wife's. All is lost, including his horses, his house, and even the very rags he has on his back.

The manner of procedure is as follows: A row of players, consisting of five or six or a dozen men, is arranged on either side of the tent, facing each other. Before each man is placed a bundle of small twigs or sticks, each six to eight inches in length and pointed at one end. Every *tête-à-tête* couple is provided with two cylindrical bone dice, carefully fashioned and highly polished, which measure about two inches in length and half an inch in diameter, one being white and the other black, or sometimes ornamented with a black band. At the rear end of the apartment, opposite the entrance, several musicians beat time on rude parchment-covered drums. The whole assembly, sitting "Turk fashion" on the ground, then commence operations. The pledges are heaped up near the players, and each couple soon becomes oblivious of all the rest. One of the gamblers incloses

a die in each hand, and, placing one above the other, allows the upper bone to pass into the lower hand with the other die. This process is reversed again and again, while all the time the hands are shaken up and down in order to mystify the partner in the passing of the dice. The other man, during the performance, hugs himself tightly by crossing his arms and placing either hand under the opposite arm, and, with a dancing motion of the body, swaying to and fro, watches the shuffling of the dice with the closest attention. When this has gone on for a few minutes, the latter suddenly points with one arm at the opposite arm of his partner, and strikes himself under that arm with the other hand. Whichever hand of his rival he chooses is to be opened, and if the dice are in it, the guesser takes them and proceeds in the same manner. If, however, he misses, and the dice are not there, he forfeits one counter, and this is taken from his bundle and stuck into the ground in front of the other. Thus the game continues until one or the other has gained every stick, when he is proclaimed the winner and carries off the stakes. During the entire game, the players, as well as the musicians, keep time to the accompaniment in their movements, and chant the while a weird, monotonous tune (?) which runs in this wise:

No words are sung, but the syllable *ah* is pronounced in a whining, nasal tone for every note. The entire party keep excellent time, and are always together, rising and falling in the scale with wonderful precision, since the tune itself is so devoid of melody that it is often difficult for a white man to acquire it. This monotonous chant is kept up for hours and even days, and the competitors seem never to grow weary. The war and dance

songs of the Utes are different from this, yet they are somewhat similar.

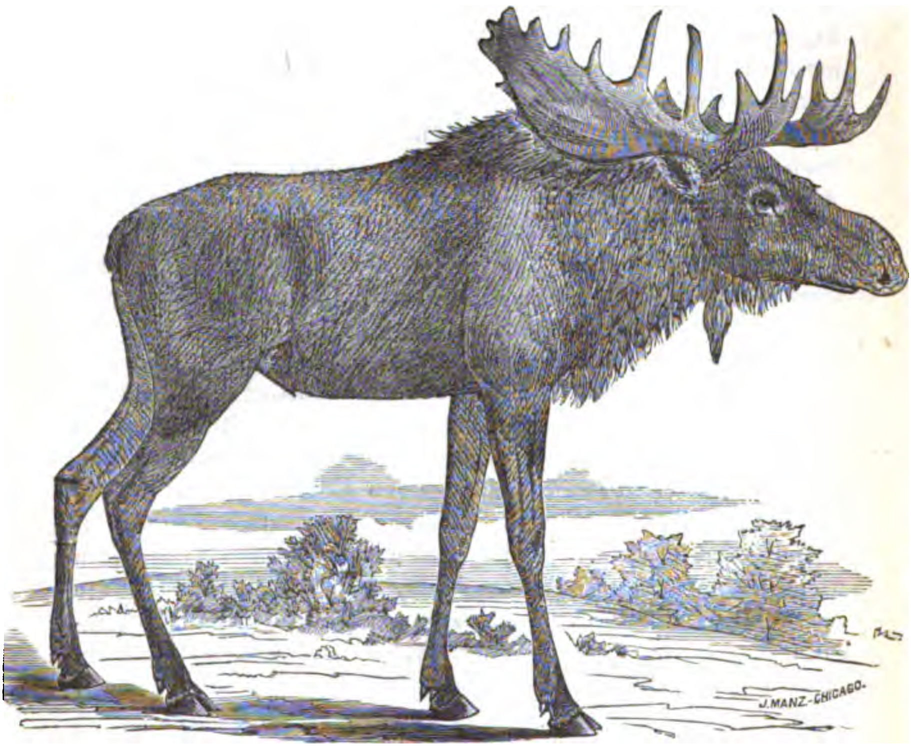
Gaming is not confined to the male sex of the tribe, but is indulged in to some extent by the squaws. During the palmy November days of Indian summer, when the whole tribe throw off care and give themselves up in a measure to enjoyment, the old crones will often gather for a game of chance, on a more limited scale. All their trinkets and gewgaws are brought out and their ornaments stripped from their persons, and the game of chance proceeds. I have frequently seen these toothless old hags quarreling over some paltry toy, with a pack of filthy playing-cards in their hands. But assuredly they do not play any standard game with them; they have methods of their own, of which I could make nothing. These cards are obtained from traders and explorers, but when they cannot be had, the squaws will simulate the American cards in their own rude manufactures: the spots are represented by fanciful devices, and the face-cards by grotesque paintings. The men usually disdain these feminine methods of gaming, and practice the more exciting mode as I have described it above.

In this connection it might be well to say a few words relating to the negligence of ethnologists in omitting to collect the songs and chants of the American tribes, when it has been in their power. This branch of the science seems to have been entirely overlooked (excepting in a few instances), though it is almost as important as many others which are studied so assiduously. That the tunes or dirges of unallied families differ to a great extent there can be no doubt, and frequently these are of as much importance in seeking to determine affinity or relationship as the study of philology. It is desirable, therefore, that every chance be seized for jotting down these native chants, as in a very few years more such opportunities will have passed away forever.

N. B. Since this paper was placed in the hands of the editor, a Bulletin has been issued by Hayden's United States Geological Survey, containing an interesting article on the Twana Indians of Washington Territory, by the Rev. M. Eells, in which their modes of gambling are mentioned. The second game played by this tribe bears a singularly striking resemblance to the above-described method, differing principally in the musical accompaniment. It is probable that the *two-bone game* was, and is still, common among many of the western tribes.

RECENT LITERATURE.

CATON'S DEER OF AMERICA.[1] — We notice this important work from advance sheets kindly furnished by the publishers. The author is well known to have devoted much time and care to the study of the *Cervidæ*, and has already published many articles on the subject which have shown him to be a close and accurate observer, and have made him the highest authority in this country respecting all that relates to the natural history proper of these valuable and interesting quadrupeds.



Male Moose.
(FIG. 66.)

In the present work we have the final outcome and thorough digest of his long studies, in the form of an exhaustive monograph which will at once become the standard authority. He is to be congratulated upon this consummation, which will redound so largely to his reputation as an

[1] *The Antelope and Deer of America* A Comprehensive Scientific Treatise upon the Natural History, including the Characteristics, Habits, Affinities, and Capacity for Domestication, of the Antilocapra and Cervidæ of North America. By JOHN DEAN CATON, LL. D. New York: Published by Hurd and Houghton; Boston: H. O. Houghton and Company; Cambridge: The Riverside Press.

observer of nature, and we congratulate ourselves upon the acquisition of so careful, so thorough, and so reliable a treatise.

We do not take the present occasion for any elaborate review of the work, in which to track after statements with the view of verifying or criticising particulars; we wish rather simply to point out the general character of the work, and bring its high average of merit and reliability prominently into view. The work is open to serious criticism in the matter of the classification which the author has seen fit to adopt,

Scandinavian Elk.
(Fig. 67.)

and we doubt that his views on this portion of the subject are sound, from a purely scientific stand-point, or that they will receive the countenance of professed therologists. But we do not think that this criticism will in the least disturb the author, who seems to have aimed at some convenient arrangement of the ruminants, by which the relations of the species he treats may be readily recognized, rather than any formal presentation of the technics of the case. And we would immediately add that his elaborate, minute, and faithful descriptions of the species put us in possession of exactly the facts that we should most wish for

were we to undertake such a classification as the author does not give. Here are the materials, in short, upon which to work at the taxonomy of the subject.

In preparing this work, the author seems to have kept steadily in view the special object of promoting a taste for natural history among those who are fond of field-sports. It is an invitation to all such to study

Red Deer or Stag of Europe.
(FIG. 68.)

natural history for the pure and high pleasures it is capable of affording when viewed in the proper light, — an invitation kind and courteous in spirit, and withal hard to refuse, so strongly does the author address us with his interesting writing and his long array of delightful description and narrative. Judge Caton is one of those pleasant, persuasive writers who will take no denial; he carries us along whether we will or not, and ends by making us wonder why everybody does not turn to keep-

ing deer and studying their structure and habits! But, quite seriously, we would urge the double delight that all sportsmen and hunters may experience, if, instead of ending their interest in game with killing it, they would capture animals and birds, and study them. This would, moreover, be excellent service rendered to science; should it ever become general, new and interesting facts would accumulate with astonish-

Male Elk or Wapiti of America.
(FIG. 69.)

ing rapidity, and the most desirable results would immediately follow. In fact it is not too much to say that in the present state of zoölogical science in this country the technical scientists, full of their skulls and teeth and dry hides and their taxonomic refinements, are turning eager eyes toward the sportsmen and practical field naturalists, in the hope of learning what they now most need to know. Judge Caton in himself

illustrates the honorable capacity of the amateur naturalist (we use the term in its best sense, implying high credit, without a shade of the reverse) to supplement museum-acquired learning with other information of equal scientific importance, of greater practical utility, and much more general interest. This is exactly what the present work very conspicuously accomplishes. It will, we make no doubt, meet with a hearty welcome, and have a wide-spread influence for good. For ourselves, engaged as we are upon a general history of North American Mammals, we would thank the author personally for a contribution so timely and so exactly to our hand; we are selfishly pleased to find so generous a slice of the work already cut and dried for our own use.

As already intimated, we do not here propose any elaborate review of the work in detail, and we close with allusion to a few leading points: the prongbuck is very fully treated in the first sixty-five pages; then follow the eight "distinct and well-defined" North American species of *Cervidæ*, namely, the moose, the wapiti or American elk, the two species of reindeer, woodland and barren-ground, the common or Virginian deer, the mule deer (commonly called black-tail in the West), the Columbian or true black-tailed deer of the Pacific slopes, and a curious little species, lately described by the Judge as new, under the name of *Cervus Acàpulcensis*. We are not acquainted with the latter; the recognition of the other seven agrees with our previous impressions on the subject, and with the now generally accepted views of the best authorities. These species occupy pp. 66–322. The work very properly continues with a comparison of the several European species. Persons are frequently puzzled by the reverse use of the terms "moose" and "elk." The author makes it perfectly clear that the American *moose* is the analogue of the palmate-horned animal called "elk" in Europe; and that the American *elk* is the analogue of the stag or red deer of Europe. From among the many characteristic wood-cuts which illustrate the volume, we have selected as most useful to reproduce for our readers the four pictures which show up this point. — E. Coues.

Recent Books and Pamphlets. Notes on the Osteology and Myology of the Domestic Fowl (*Gallus domesticus*), for the use of Colleges and Schools of Comparative Anatomy and for the Independent Zoölogical Student. By Victor C. Vaughan, Ph. D. Sheehan & Co. Ann Arbor, Mich. 1876. 12mo, pp. 116, with cuts. $1.50.

How to Camp Out. By John M. Gould. New York: Scribner, Armstrong, & Co. 1877. 12mo, pp. 134.

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Revisio critica Capsinarum, Præcipue Scandinaviæ et Fenniæ. Ab Odo M. Reuter. Helsingfors. 1875. 8vo, pp. 190.

South Kensington Museum Science Handbooks. Branch Museum, Bethnal Green. Economic Entomology. By Andrew Murray, F. L. S. Aptera. Chapman and Hall, 193 Picadilly, London. 12mo, pp. 433, with numerous cuts.

Capsinæ ex America boreali in Museo Holmiensi asservatæ, descriptæ ab O. M. Reuter. Stockholm. 1875. 8vo, pp. 33.

Bidrag till Kännedomen om nagra Hemipterers Dimorphism. Ab O. M. Reuter. Stockholm. 1875. 8vo, pp. 10.

U. S. Entomological Commission. Circular 1, 2. Bulletin 1. Destruction of the Young or Unfledged Locusts. Washington, D. C. Department of the Interior. U. S. Geological and Geographical Survey of the Territories. F. V. Hayden in charge. 8vo, pp. 12.

The Insects of the Tertiary Beds at Quesnel, British Columbia. By S. H. Scudder. From the Report of Progress 1875–6. Geological Survey of Canada. 8vo.

Variations in the Colors of Animals. By S. W. Garman. (Reprinted from vol. xxv. of the Proceedings of the American Association for the Advancement of Science.) Salem. 1877. 8vo, pp. 17.

On the Brain of Coryphodon. By E. D. Cope. (Proceedings of the American Philosophical Society, March, 1877.) 8vo, pp. 5, two plates.

Studien an Turbellarien. Beitrage zur Kenntniss der Plathelminthen. Von Charles Sedgwick Minot aus Boston. (Arbeiten aus dem Zoologisch-Zootomischen Institut in Würzburg.) Hamburg. 1877. 8vo, pp. 83, 5 plates.

Die Verwandtschaftsbeziehungen der gegliederten Thiere. III. Strobilation und Segmentation. Ein Versuch zur Feststellung specieller Homologien zwischen Vertebraten, Anneliden und Arthropoden. Von C. Semper. (Arbeiten aus dem Zoologisch-Zootomischen Institut in Würzburg. Bd. iii. Heft 2, 3.) 8vo, pp. 289, 11 plates.

Discours prononcé par J. J. A. Worsae, Vice-Président devant la Sóciété Royale des Antiquaires du Nord, à l'occasion du 50me Anniversaire de la Fondation, dans la Séance du 28 Janvier, 1875. 8vo, pp. 39 (with portrait of Rafn).

Descrizioni di alcune Specie di Opilioni dell' Arcipelago Malese appartenenti al Museo Civico di Genova, pel Dott. T. Thorell. 8vo, pp. 28. 1876.

Due Bagni exotici descritti dal Dott. T. Thorell. Genova. 1877. 8vo, pp. 10. (Estratto dagli Annali del Museo Civico di H. Nat. di Genova.)

Ueber Helicopsyche als eine der Schweiz, Insectenfauna angehorende Phryganide erkannt. Von C. von Siebold. 8vo, pp. 7.

Beitrage zur Schmetterlings-Fauna von Surinam. Von H. B. Möschler. 8vo, pp. 60, two plates.

Estheria Californica Pack. Inaugural-Dissertation zur Erlangung der Phil. Doct. Von H. Lenz. 8vo, pp. 16.

Die Stammväter unserer Hunde-Rassen. Von L. H. Jeitteles. Wien. 1877, 12mo, pp. 68.

Indices d'au nouveau Genre de Mammifères édentes, Fossile dans les Dépôts eocenes dits de Saint Ouen. Par Paul Gervais. 4to, pp. 5.

Observations relatives à un Squale Pèlerin récemment pêché à Concarneau. Par MM. Paul Gervais et Henri Gervais. 4to, pp. 5. (Extrait des Comptes rendus des Sciences de l'Académie des Sciences. 1876.)

Round the World in 320 days. Six Months of Inland Excursions. Programme of the First Voyage. Organized by La Société des Voyages d'Etudes autour du Monde. London: Trübner & Co. 1877. With plan and chart. 12mo, pp. 54.

GENERAL NOTES.

BOTANY.[1]

VEGETABLE DIGESTION.[2] The following note is an abstract of Professor Morren's communication: —

There is no doubt that certain plants have the power to allure, retain, kill, dissolve, and absorb insects and even larger animals. There is nothing astonishing in this, for to my mind the facts observed among the carnivorous plants are in perfect harmony with the general theory of the nutrition of plants.

Digestion is not the exclusive characteristic of carnivorous plants, but is common to all living beings, animal as well as vegetable. In animals, digestion in its essence is considered by chemists to be an indirect fermentation, consisting of an hydration, followed by a splitting up into new and more simple forms of the digestible materials. These marvelous and necessary transformations are accomplished by the action of mysterious and powerful substances called ferments. The ferments are derived, according to all appearances, from the albuminous matters, and seem to be a part of the protoplasm itself. They are more or less distributed throughout all the animal organism, but particularly abundant in the juices which are secreted especially in view of digestion, such as the saliva, gastric, pancreatic, and intestinal juices. They may be extracted in a separate form and their activity still be preserved.

The food, as it is taken in by the animal, is not usually in a state fitted to pass into the system, and these ferments act upon it and produce the necessary changes, the albuminoids pass into "peptones," starch into sugar, fats into an emulsion, each class of foods being transformed by its own appropriate ferment.

Plants also take in their food in a crude state, and digestion is as essential with them as with animals. The ferments form an integral part of the vegetable organism, and are even more numerous in the vegetable than the animal kingdom.

Diastase or *glycosic ferment.* This is the digestive ferment of amylaceous substances. By its influence starch is hydrated and divided into the readily soluble products, dextrine and glucose —

$$2(C_6H_{10}O_5) + H_2O = C_6H_{10}O_5 + C_6H_{12}O_6$$
$$\text{Starch} + \text{water} = \text{dextrine} + \text{glucose.}$$

In animals these changes are brought about by the saliva and pancreatic juice. A fine illustration of this action among vegetables is seen in the germination of masses of barley, or malting as it is commonly termed.

[1] Conducted by PROF. G. L. GOODALE.

[2] *La Digestion Vegetale*, note sur le rôle des ferments dans la nutrition des plantes, communiquée a l'Académie Royal de Belgique dans sa séance du 21 Octobre, 1876. Par M. EDOUARD MORREN, Professor a l'Université de Liége.

This action of diastase probably takes place when any reservoir of starch is used by a plant for purposes of growth. "We are not to occupy ourselves here with the nature and origin of diastase, still less with its action. . . . . Suffice it to state for the present that chemists establish no distinction between the animal and vegetable diastase, of which the power is the same and the rôle identical."

"*Ferment inversif.*" Saccharose, like starch, is a ternary compound accumulating in certain tissues in view for its need in nutrition, as in the stem of the sugar-cane, or root of the sugar beet. Though soluble it is not assimilated as such by animals, but is split up by this transposing ferment into glucose and levulose or transposed sugar.

$$C_{12}H_{22}O_{11} + H_2O = C_6H_{12}O_6 + C_6H_{12}O_6$$
$$\text{Saccharose} + \text{water} = \text{glucose} + \text{levulose.}$$

These changes are seen on a grand scale in the beet root during the flowering of that plant.

Emulsive and *saponaceous ferment.* The fat bodies are digested in the intestines of animals by means of pancreatic juice by first making them into a fine mechanical mixture followed by a somewhat complicated chemical change called saponification, or hydration and division into glycerine and fatty acids. For example: —

$$C_3H_5(C_{18}H_{33}O.O)^3 + 3H_2O = C_3H_8O_3 + 3(C_{18}H_{33}O.HO)$$
$$\text{Trioleine} + \text{water} = \text{glycerine} + \text{oleic acid.}$$

This same ferment exists in vegetables. Oleaginous seeds when ground up in water form an emulsion, and if allowed to stand for a time glycerine and fatty acid are produced. There is no doubt that the oils and fats in vegetables constitute a nutritive provision, as the grains of Crucifers, Linum, and bulbs of the Onion will show.

Albuminous ferment; pepsine. We come now to the digestion of nitrogenous substances under the influence of the pepsine of the gastric juice. Mr. Darwin, as his work on Insectivorous Plants will show, believes there is no doubt but that plants have this same power, and quotes M. Frankland's experiments, in which he found pepsine in the glands of the Drosera. More recently MM. Max Rees and H. Will (Bot. Zeit. 29 Oct., 1875), have extracted this ferment by the usual process, and with it they have caused artificial digestion of fibrine. It is in the grains that there is most frequently found a considerable quantity of albuminoids stored up as gluten, legumin, and aleurone to serve the requirements of the germinating plantlet. These substances are usually in an insoluble state, but are dissolved as required. The ferment doing this valuable work of solution is not thoroughly understood. MM. Gorup-Besanez and H. Will (Bericht der Deutsch. Chem. Gesells., Berlin, 1874, p. 1478) state that the seeds of *Vicia sativa* contain with starch a notable proportion of legumin, and when these seeds germinate the legumin disappears, and *leucine* and *asparagine* are produced; and they presume these bodies result from a division produced by a

ferment residing in the seed. The grains of Vicia were treated first for forty-eight hours with alcohol and afterwards with glycerine. Drops of such solutions were placed on starch of which notable quantities were changed into sugar, while similar liquids in which seeds had not been digested produced no change. It is safe to conclude that the existence of a pepsine ferment is established in the vegetable kingdom. Thus we have established among plants the digestion of starch, sugar, oils, and albuminoids, precisely the four normal kinds of digestion in man and animals. But we find still other and often very complicated vegetable ferments, such as the *myrosine* causing the mustard fermentation, and *pectose* of the pectic fermentation.

The similarity of composition of milk and endosperm, or in other words the food of the young animal, and young plant, has long been noticed. As an illustration we give the following: —

WHEAT FLOUR (DRY).			COW'S MILK (DRY).		
Starch . . .	780	800	Sugar of milk . .	347	605
Fatty matters .	20		Butter . . .	258	
Gluten . . .	170	190	Caseine	242	339
Albumen . .	20		Albumen . . .	95	
Salt . . .		10	Salt		56
		1000			1000

Both contain two ternary and two nitrogenous ingredients. During germination the endosperm undergoes nearly the same changes as the milk in the digestive system of the animal. The digestive power of vegetation appears very evident if we consider those plants destitute of chlorophyll. Thus the Bactaria and similar plants are representatives of fermentation. But the majority of plants have chlorophyll, and their activity differs from those without it, by their absorbing carbonic dioxide and elaborating their own food.

To consider only the phenomena which interests us at this moment, one recognizes three very distinct and consecutive functions, namely, *elaboration*, *digestion*, and *assimilation*.

Elaboration has for its part the production of carbohydrates out of carbon dioxide and water. It is characteristic of chlorophyll, and takes place in sunlight, the type of its products being starch ($C_6H_{10}O_5$).

Digestion takes place in protoplasm in the presence of oxygen with a production of carbonic dioxide. It consists in a hydration not accompanied by a molecular change, by which the elaborated matter is dissolved and diffused, starch passing into glucose ($C_6H_{12}O_6$).

Assimilation is the fixing of these digested materials into the texture of the plant, the glucose passes into permanent cellulose ($C_6H_{10}O_5$).

All these processes may be confined to a single cell, as in many unicellular plants, while in the higher forms the labor is much divided.

Protoplasm includes the sum total of vegetable activity. The cells remain active during a definite time, that is to say, while their protoplasm continues to live in the shelter of the protecting membrane which it it-

self has made; finally it abandons the cell to pass to others towards the new centres of activity, but the tissues, organs, members, the organisms thus constructed remain to attest that life has passed that way, that they are the works of the activity of an organism, like the shell abandoned by the mollusk.

Much wrong has been done in contrasting the nutrition of animals with vegetables. They are the same and ought to be studied in a parallel manner. The only difference, to the advantage of vegetables, consists in this, that plants when they have utilized and applied the supplies which they possessed, have the power of taking up inorganic materials and elaborating them into new organic food, but after such elaboration, nutrition accompanied by respiration, circulation, transformation, and assimilation take place as in animals. In effect the plant, wheat, for example, accumulates a supply of nourishment in the grain near the embryo. If this accumulation feeds an animal or nourishes the plant itself, it behaves in the same manner. In the one case it is reduced to a pulp, submitted to the influence of the pancreatic, gastric, and other juices, and is finally absorbed. If the grain is placed under conditions for germination like reduction and transformations are undergone, and the plant is nourished instead of an animal.

The truth of these assertions has been demonstrated by the interesting experiments of M. Ph. Van Tieghem, upon the germination of the *Belle de Nuit* (Recherches Phys. sur la Germination. Ann. des Sc. Nat. 1873.) This able observer has nourished the embryos extracted from the grains and separated from their endosperm by means of paste of the starch of either potato or buckwheat. The grains of starch in contact with the embryo were dissolved, which proves that the necessary ferment resides in the embryo.

Many peculiar organic compounds are common to both forms of life. Formic acid, for example, found among ants, corresponds to that found in many nettles; butyric acid in perspiration to the pulp of tamarinds; palmetic acid in animal fats to the fruit of palm; oxalic acid is quite common to both; and there are numerous other like examples.

Protoplasm of both forms of life are alike, or at least, give the same reactions and have the same movements. The only thing living in a plant is its protoplasm, as it makes the cells and constructs the organism. The same may be said of the animal structure. Thus we are able to infer identity of effect from identity of cause. The unity of structure is the corollary of the unity of nutrition.

To return to carnivorous plants, we are able to recognize that abstraction made on account of their singular structure, enters as a particular case in the general theory. The most interesting thing which they present is the presence of pepsine ferment at their surface in a secreted liquid.

It is well to notice that the facts ascertained among the Droseraceæ, so strange that they have been styled idle stories, have had this happy

result, that they have opened a new horizon upon a simple and general theory.

Professor Morren closes his paper by stating his hope and desire to go still further in this difficult and interesting line of research.—BYRON D. HALSTED, Bussey Institution, March 14, 1877.

ON THE POROSITY OF WOOD.—Professor Sachs has published a preliminary communication in regard to the porosity of wood, which contains notes of many interesting experiments. Two of these will be now briefly noticed. 1. The best grade of artist's vermilion was treated with a large quantity of distilled water and repeatedly filtered through filter-paper. The pigment was now left in so fine a state that it exhibited the well-known Brownian movement. Fresh cylinders of wood three to four cm. long, cut from a living stem of a conifer, were fastened to the lower end of a glass tube which at the upper part communicated with a broad vessel; tube and vessel were filled with the pigment emulsion so that the wood was under a constant hydrostatic pressure of 160 cm. Even at the end of three days the water which filtered through was perfectly clear and contained no trace of the vermilion. The upper transverse sections of the cylinders showed that all the layers of the spring-wood were bright red, the autumn layers were not red at all, or at most only in radial stripes, the heart-wood was wholly uncolored. On splitting the cylinder of wood, the vermilion was seen to have penetrated nowhere deeper than two to three millimeters, corresponding to the length of the cells in the wood employed; the rest of the wood was colorless. The microscope shows that the majority of the spring-wood cells are wholly filled with vermilion even to their lower tips; also that the bordered pits of these cells are thickly filled with vermilion, and sometimes this did not pass through into the neighboring cells which seemed to be in communication with them; there was obviously an obstruction in the bordered pits themselves. This is interpreted as showing that there still remains in the discoid markings, a thin membrane as claimed by Hartig. The autumn wood cells appeared to take up very little vermilion, and the medullary rays none. "These results confirm Hartig's and Sanio's views, that the bordered pits of the spring and a part of the autumn wood are *closed*. Nevertheless there exist at the dividing line between the autumn and spring wood passages which allow air to penetrate." The latter is shown by fastening a three to four cm. cylinder of wood from a living stem, to a bent tube holding mercury and by this means exerting a pressure of fifteen to twenty ct. If the whole is placed under water, the line between the autumnal and the spring wood will be seen to emit a circle of bubbles; but no air bubbles will escape from the first autumnal cells or the last spring cells. This experiment has been tried with the wood of the fir in January, and with *Pinus Laricio*, *Pinus Brutia*, and *Pinus pinsapo* in February. Both fresh and air-dry fir gave

this result; but if the wood is artificially charged with water, no air can be forced through it.

Another portion of the paper refers to the resistance which the walls of wood cells offer to filtration. If distilled water and fresh wood be used, filtration can be conducted with great rapidity. The rate diminishes after a very short time. Professor Sachs has also examined the amount of air in cell-cavities. This amount he has endeavored to determine by a series of calculations, and he gives the following results: —

Fir-stem, 100 cubic centimeters 25 cc. of cell-wall, 58.6 cc. water (in the cell cavities and imbibed by the walls), 16.4 cc. air-space. Geleznow had obtained different results, namely: 100 cc. fresh Betula alba wood contain 32.4 cc. cell-wall, 33.2 cc. water, 34.4 cc. air-space.

It may be said in conclusion that Professor Sachs has found reason for emphasizing the statement in his text-book that a distinction must be made between the passage of water through wood by means of capillarity acting in the capillary cells, and by adhesion to the cell wall. The communication will lead botanists to look with interest for the memoir of which the present short paper is only a forerunner.

ONION SMUT.[1] — Dr. Farlow's essay on this subject is of great value as well to the agriculturist as to botanical science.

The smut plant (*Urocystis Cepulæ*) makes its appearance upon the onion leaves while they are still quite young, often changing the central portion into a mass of black, dusty spores, previous to the formation of which the threads of the fungus have penetrated like a network among the cells of the leaf tissue.

It is peculiar to America, and has probably come from some of our wild species of onion. As a means of checking its ravages, which are now limited to only a few localities, the author suggests as a wise precaution, the destruction of all wild and useless species of onion. Ground on which the smut has appeared should be burned over, and the earlier in the season the better. A knowledge of allied species, supported by a limited experience of the disease in hand, tends to show that the smut spores do not retain their vitality for more than four years; therefore by growing some other crop for a few seasons a partial eradication at least might be expected.

It remains for the suffering onion growers to profit by this excellent instruction, and do all in their power to prevent the spread of the disease into new localities.

With the aid of the plate, in which are figured the plant under consideration, rye smut, and spores of the corn smut, the relations which the onion smut bears to some of the other members of the order *Ustilagineæ* are pointed out. In a note at the close of the paper the new fungus is botanically described. — B. D. H.

[1] *Onion Smut.* An essay presented by DR. W. G. FARLOW, of Harvard University, to the Massachusetts Society for Promoting Agriculture, and published with a plate in their Twenty-fourth Annual Report

SETS OF ALGÆ. — We have received the first fasciculus of Algæ Exsiccatæ Americæ Borealis, published by W. G. Farlow, C. L. Anderson, and D. C. Eaton. The present number comprises fifty species, principally from Key West and California, and is to be followed by other fasciculi, including the greater part of the marine species of the United States and some of the more interesting fresh-water algæ. The fasciculi will be of two different sizes: one of the size of Sullivant's Musci Cubenses, containing Florideæ and Chlorosporeæ, and the other of the size of ordinary herbarium sheets containing the larger Fuci, Laminariæ, etc. The price of the smaller sized fasciculus is $8.00, and of the larger, $12.00. In order to be able to include some of the rarer species in the series only a limited number of sets have been prepared, of which a few are offered for sale, and may be obtained by addressing Prof. W. G. Farlow, 6 Park Square, Boston.

SAXIFRAGA VIRGINIENSIS, *flore pleno.* — A prettier plant in its way than this double-flowered wild Saxifrage we have never seen. It was discovered by Mr. Joseph S. Adam, in Canaan, Connecticut, and is a perfectly spontaneous production, first noticed as a single plant, but is now multiplied into two or three, one of which is given to the Cambridge Botanic Garden. It is a tall specimen for the species; the stalk bearing seventy or eighty flowers; and each one bears as many petals, in a full rosette, a quarter inch in diameter, pure white. The inflorescence has the look of double-flowered *Spiræa filipendula*, or of a variety of *Cardamine pratensis*, which used to be in the gardens. The calyx is unchanged, an imperfect pistil is occasionally found in the centre; but the rest of the flower consists of petals only, in many ranks. We trust it may be preserved in cultivation. — A. GRAY.

BOTANICAL PAPERS IN RECENT PERIODICALS. — *Flora*, No. 5. Batalin. Mechanism of the Movements of Insect-Eating Plants (continued in numbers 7 and 9, but not yet finished). Dr. E. Duby, New Mosses. Dr. J. Müller, Lichens from Texas. No. 6. Dr. Scriba, A Notice of the Life of Dr. F. W. Schultz. F. Buchenau, The Cross-Section of the Capsule in the German *Junci* (with a plate giving the transverse sections of 18 species). No. 7. Dr. E. Stahl, An Explanation of Hymenialgonidia. No. 8. H. G. Holle, On the Activity of Assimilation in *Strelitzia reginæ.* (Not finished in 8 or 9.)

Botanische Zeitung. No. 11. Notice of Agardhi's *Species, Genera, et Ordines Algarum.* No. 12. R. Caspary. Remarks in regard to the Protective Sheath of Vascular Bundles. (Noticing objections to his use of the word protective-sheath (Schutzscheide.) No. 13. R. Caspary, On *Nymphæa Zanzibariensis*, n. sp. No. 14. Dr. Nowakowski, On Conjugation in some *Entomophthoræ.* No. 15. Otto Kuntze, Preliminary Report in regard to Cinchona. (Continued in No. 16.)

ZOÖLOGY.

Amphioxus in the Bermudas. — It may interest the readers of The Naturalist to hear that *Amphioxus* has been discovered in the Bermudas. Mr. J. Matthew Jones and I have dredged it in the swift tide-way near the bridge at Flatts Village. The animals vary in length from three quarters of an inch to an inch and a half, and appear to be quite abundant in a belt of coarse sand in two to three fathoms of water. — G. Brown Goode, Hamilton, Bermuda, April 4, 1877.

Thelyphonus giganteus poisonous. — Dr. H. C. Yarrow forwarded us in February, 1875, a specimen of this arachnid, with a letter from Dr. J. F. Broughter, of Fort Craig, New Mexico, in which he states his belief that this animal is poisonous, and adds, "I know the Mexicans here regard it as extremely poisonous." He incloses the following extract from a letter of Dr. Lewis C. Kennan, of Santa Fé, N. M.: —

"In regard to the *Thelyphonus giganteus*, I have *no doubt* of its venomousness; I can demonstrate the poison apparatus. While stationed at Fort Buchanan, on the border of Sonora, in 1855, I knew an Indian boy bitten on the temple who *never recovered*. Several horses were bitten on the lip, champing the insect in their hay, and the tumefaction and general distress were as great as from the bite of a rattlesnake. The insect is so extremely sluggish that great violence is necessary to make them bite. I had a French servant who frequently brought them to me in his hands and pocket, and I even suspected the omnivorous Gaul of cooking and eating them as a sort of land lobster, but they never troubled him in any way. The belief in their venomousness is universal in Mexico. To my mind the fact is beyond question. If not, what is the teleology of the fangs?"

New Entomological Works. — Bulletin, No. 2, vol. iii., of Hayden's United States Geological Survey of the Territories is a bulky pamphlet of 340 pages, containing three papers with the following titles: Western Diptera: Descriptions of New Genera and Species of Diptera from the Region West of the Mississippi, and especially from California. By C. R. Osten Sacken. Report upon the Insects collected by P. R. Uhler during the Explorations of 1875, including Monographs of the Families *Cydnidæ* and *Faldæ*, and the Hemiptera collected by A. S. Packard, Jr., M. D. By P. R. Uhler. Descriptions of the Araneæ collected in Colorado in 1875 by A. S. Packard, Jr., M. D. By T. Thorell, with an appendix by J. H. Emerton.

We may state what is not mentioned in Professor Thorell's paper, that he found several species of spiders in Colorado, closely allied to Northeastern Asiatic forms. This is confirmatory of our statement in the Monograph of the United States Geometrid Moths, that we found several Colorado moths of this family closely allied to those found on the

plateau of the Altai Mountains. Within a few days we have received a letter from Dr. Standinger, who writes, in acknowledging the receipt of a copy of the monograph, "By the excellent pictures I recognized different North American species as identical with some from Europe or North Asia, described a long time since."

CRITICISMS OF HAECKEL. — There has recently appeared a third edition of Haeckel's Anthropogenie, in which he attempts to explain man's origin in accordance with the principles of evolution. He enters into the subject in detail. He has also written a work on the General History of Creation. His agreeable style and polemical skill have secured for these books large sales, so that Haeckel's influence over the public in Germany is very great and has now extended to other countries. He has likewise propounded various theories which have demanded the attention of zoölogists. Under these circumstances it becomes a matter of especial interest to learn the opinions of competent critics. All the published criticisms by zoölogists of acknowledged high standing with which I am acquainted are unfavorable, while the praises, which the writer personally has heard, were bestowed for the most part by young persons.

Professor Haeckel's book is provided with numerous illustrations. Professor His [1] states that on page 242 of the first edition of the Schöpfungsgeschichte there are three figures, one of the egg of man, the egg of an ape, and the egg of the dog, which are referred to in the text as showing the identity of the primordial egg in mammals, but Professor His calls attention to the fact that they are electrotypes of one and the same wood-cut. On page 170 Professor His calls attention to the fact that Haeckel gives figures of an embryo dog and human fœtus, the former of which is supposed to present a copy from Bischoff, the latter from Ecker. The forehead in the dog is three and one half mm. longer than in Bischoff's figure, while that of the human embryo is two mm. shorter than the original, and made still smaller by the eye being drawn five mm. further forward, while the tail is twice as long as in the original. Professor Haeckel's figures present the closest similarity with one another.

Professor Bischoff [2] directly contradicts Haeckel's assertion that we cannot discover, even with the aid of the best microscope with the highest power, any essential difference between the egg of man and those of most of the higher mammals, and states that the pictures showing the identity of mammalian embryos in Plate V. of Haeckel's Anthropogenie differ essentially from the reality, and, finally, that the figures of apes' faces given by Haeckel on his title-page show a great agreement existing between the features of apes and of the lower human races, but that this resemblance does not appear in photographs.

[1] Flis Unsere Körperform. Leipzic 1875. Page 168.

[2] Sitztun. math. phys Classe der k. b. Akad der Wiss. München. 1876. Heft i., page 1.

Mr. Balfour [1] also cites Haeckel as having refigured one of his sections, employing a coloration to distinguish the layers, not founded upon Balfour's statements, but on the contrary in direct opposition to them.

Professor Hensen in his article on the Development of the Rabbit, in His and Braune's *Zeitschrift für Anatomie und Entwickelungsgeschichte*, volume i., calls attention to Haeckel's picture of spermatozoa within the yolk of a mammalian egg, a thing which no man had ever seen up to that time.

Professor Semper has openly attacked Haeckel, first in a lecture entitled Der Haeckelismus in der Zoölogie, published in Hamburg, in 1876, and again in Offener Brief an Herrn Professor Haeckel in Jena, which has just come out. In the latter especially, numerous points are noted, all telling against Haeckel: thus on page 20 he says that Haeckel's figure of a section through an annelid's head is incorrect, because it contains a cardinal vein, genital glands, liver sacks, and segmental organs, and none of these organs exist in the head; the sexual glands are drawn, too, on the dorsal side of the body, whereas they always lie on the ventral side.

Professor Haeckel further makes statements of fact: one of these is that Goethe was an evolutionist. Kossmann, in a pamphlet which I have not at hand, has reviewed the citations from Goethe, and concludes that Haeckel's assertion is false. Oscar Schmidt [2] draws the same conclusion.

Semper in his Offener Brief, page 11, affirms that Haeckel's view that the Echinoderms are formed by worm colonies is belied by the facts of anatomy and embryology.

Mecznikow, F. E. Schulze, Oscar Schmidt, and Barrois in their recent investigations on the sponges have questioned the accuracy of Haeckel's observations on the embryology of these animals. But this subject is not thoroughly worked up yet, and Haeckel may be right after all; but we pass to other criticisms.

Mr. Alexander Agassiz [3] condemns the "startling hypothesis of the genetic connection between the Geryonidæ and Æginidæ, . . . called by Haeckel allæogenesis," and propounded in his memoir on the Rüsselquallen. Agassiz adds that two short papers, recently published by Schulze and Ulianin, prove conclusively that "Haeckel's theory, like so many other of his vagaries, had no foundation in truth. It was based not merely on an incorrect interpretation of facts, but the facts themselves existed only in his imagination. As perhaps, with the exception of his monograph of the Radiolaria, no other memoir has contributed more than the one above quoted to give Haeckel the position he holds among zoölogists, we may be allowed to remind the Haeckelian school of nat-

[1] Journal of Anatomy and Physiology, vol. x, page 521, note.

[2] Deutsche Rundschau. O. Schmidt. April, 1876, page 95.

[3] Silliman's Journal. May, 1876, page 420.

uralists that this same genetic connection has furnished the text for many a sermon from their high priest. Infallible himself, he has been unsparing in his condemnation of the ignorance and shallowness of his opponents. Proved now to be in the wrong, we expect, therefore, justice without mercy from this stern scientific critic, and look forward in the next number of the *Jenaische Zeitschrift* for a thorough castigation of Haeckel by Haeckel, showing up the absurdity of allæogenesis and all that hangs thereby."

Finally, Professor Haeckel has proposed various theories. The most widely known of these is his Gastræa-Theorie. The inspiration of this was the theory of the germinal layers being homologous in all classes of animals. Do not let us confuse matters, but remember that this theory was suggested by Von Baer[1] in 1828, and by Rathke half a century ago. It was brought prominently forward by Kleinenberg in his memoir on Hydra, and then further established by Mecznikow and Kowalewsky, and since by numerous observers.

The Gastræa-Theorie is an attempt to explain these homologies. Claus[2] proves that this is unsuccessfully tried, because it disagrees with the facts in many cases. He further points out that Haeckel has contradicted himself several times flatly in his system of classification.

Haeckel has proposed a biogenetical fundamental law (biogenetisches Grundgesetz), namely, that embryology is the repetition of phylogeny. This is merely a misshapen repetition of the principle taught by Agassiz, that the embryos of higher animals resemble the adults of lower forms. Kölliker[3] demonstrates the falsity of Haeckel's mode of stating the case by noticing some of the conclusions he draws, but which are disproved by facts.

It does not seem to me desirable to continue these quotations and references, for I think that the inaccuracy of Haeckel's pictures, of his statements of facts, and finally of his theories, has been sufficiently indicated. I close with a quotation from Professor His's Unsere Körperform, page 171: —

"I myself have grown up in the faith that among all the qualifications of a naturalist, the only one which cannot be spared is accuracy and an unconditional respect for the truth. At present, also, I still hold the view that the absence of this one qualification tarnishes all others, may they be never so brilliant. Others may, therefore, admire Mr. Haeckel as an active and relentless party leader; in my judgment he has, by his very manner of attack, resigned his right to be reckoned an equal in the circle of serious investigators." — CHARLES SEDGWICK MINOT.

[We should not lose sight of the fact that Haeckel stands as an original investigator far above some of his critics. He has established a dis-

[1] Uber Entwickelungsgeschichte der Thiere. Theil I., page 245.

[2] Die Typenlehre und E. Haeckel's sog. Gastræa-Theorie. Vienna, 1874.

[3] Entwickelungsgeschichte. 2te Aufl., page 392.

tinct school in biology. His works on the Monera, the Rhizopoda, the Sponges, Infusoria, Acalephs, etc., besides his masterly drawings and elegant literary style, should be taken into account in judging of his influence on the progress of zoölogy. — ED. NATURALIST.]

NOTES ON THE BEAVER. — Along the banks of the Grand River, Northwestern Colorado, in the year 1874, I had an opportunity of examining the work of a colony of beavers. I was first apprised of the vicinity of these animals by noticing a timber-shoot or clearing scooped out from the willow-brake to the edge of the water. It had the appearance of having been recently used, and the dragging of the logs had hollowed out the channel down to the brink of the stream. Through this slide I passed into a grove composed of slender willows which formed an almost impenetrable thicket. About fifty feet from the river was a circular clearing where the animals had been at work. Here the trees were larger, and many of them had been cut off obliquely within six inches of the ground, almost as nicely as though done with a steel axe. The logs had been hauled away, leaving an opening in the dense thicket. Farther on, larger trees had been felled which were still remaining, the majority of them measuring six and eight inches in diameter, and one tree, which had been completely severed, measured at least fourteen inches. The wood had been gnawed around the circumference, a few inches from the base, the deepest cutting having been done on the side next the water, so that the tree might fall in that direction. A few, however, had been felled so as to fall away from the river, which fact serves to show that these animals are endowed with an instinctive sagacity nearly approaching reason; for if they were guided merely by ordinary animal instinct, no mistakes would be made. Does not the bird build her nest as perfectly the first time as after years of practice? On the contrary, the beaver seems to be benefited by experience, and just as man arrives at proficiency through his mistakes the beaver profits by his errors. I noticed that wherever there were trees which had been felled some time past and fallen in the wrong direction, the newer work had been accomplished, without exception, in a systematic manner, all of the logs being cut so as to fall toward the dam. As I passed along the bank of the stream, I observed about ten timber-shoots, running parallel, at right angles to the course of the current, and separated by about fifteen feet. The larger trees had been cut near the water and above the dam for the purpose of floating them down, to save the labor of dragging from the interior. I must have interrupted them at their work, as some of the cutting was perfectly fresh, and large, damp chips lay profusely around trees which had not been entirely severed. In one place where a tree had been cut almost through, water was dripping from the notch, showing where a beaver had just been at work. I picked up several chunks of wood, six or eight inches in diameter and about as much in length, the ends being obliquely parallel.

These had probably been prepared to fill up chinks in the walls of the dam. The trees had been, for the most part, cut into sections averaging ten feet in length, and the branches and twigs had been trimmed off as cleanly as a wood-chopper could have cut them. Along the banks of the White River, some weeks before, I noticed several artificial canals which had been dug out in the absence of natural side-channels in the river. These were designed for floating down logs. One canal was four feet in width, seven in length, and several feet deep. — E. A. Barber.

ANTHROPOLOGY.

Cremation among the Sitka Indians. — During the writer's residence at Sitka, the capital of Alaska Territory, he had the opportunity of witnessing the interesting ceremony of cremation as performed by the Sitka Indians.

The subject of this solemn rite was the dead body of an old squaw, who was the mother of a numerous progeny. The day fixed for its consummation was the one immediately succeeding her death. About nine o'clock on the morning in question, four of us filed through the wooden stockade that separates the town of Sitka from the Indian village. After threading our way for some distance among the rocks along the beach, and through the filth which invariably surrounds an Indian habitation, we at length reached the dwelling-place of the deceased. As we approached we were greeted by the barking of a dozen or more wolfish-looking dogs. The hut was a substantial one, built of logs so carefully hewn that one could scarcely believe that their smooth surface was not due to the plane of a carpenter. The roof was formed of long, thin slabs, split from spruce or cedar trees, and had but a slight pitch. Immediately over the centre of the house a large rectangular hole was cut in the roof to give egress to the smoke arising from the fire within. To prevent the snow and rain from descending through this opening, a short ridge-pole, held up by two small forks which were fastened, one at each end of the hole, to the main ridge-pole, supported a covering of long slabs whose lower ends rested upon the main roof, while the upper ones projected far enough to screen the interior in a great measure from the uncomfortable effects of the driving storms.

The only entrance was through a circular hole about two feet in diameter, placed about six feet above the ground, and reached by half a dozen steps. Through this hole we had to crawl on our hands and knees, and by a corresponding descent on the inside we reached the floor, which was also made of slabs laid upon the ground, except a place about eight feet cut in the middle where the fire is built.

At the end opposite the door was erected a kind of closet, arranged with shelves, upon which were stored the winter supplies of smoked salmon, seal oil, and dried berries, together with the usual stock of blankets and peltries.

In one corner of the room we found the corpse, completely incased in blankets, which in turn were enveloped by a large, woven sea-grass mat, and tied up in such a manner as to bring the knees nearly to the chin, and thus enshrouded it was placed in a sitting posture. The house was about half-filled with Indians, — men, women, and children.

On one side of the room a young brave was busily engaged with a pair of scissors in cutting off the long black hair of all the near relatives, both male and female. This seems to be one of the usual mourning customs among these Indians. After he had completed this tonsorial duty, during which he had been frequently interrupted by their sudden outbursts of grief, a procession of about twenty Indian warriors, headed by old An-a-hoots, the war chief of the tribe, filed slowly through the small portal. Each carried in his hand a long slender staff made of hard wood and carved all over with fantastic figures, while bright-colored Hudson Bay blankets fell in not ungraceful folds from their broad, square shoulders. These staves bore evidence of their great age by the high polish they possessed, as well as by their smoky color and pungent odor. The warriors ranged themselves in line along one side of the house, facing the centre, and immediately began a lugubrious death chant, keeping time by raising their staves about three inches from the floor, and letting them fall together. This doleful air was much more monotonous than musical.

All this time the relatives of the deceased were rending the air with their lamentations. Every Indian present had his face thickly smeared with a fresh coat of seal oil and black paint, thus rendering himself almost inconceivably hideous.

At the close of the death song two stalwart young braves mounted to the roof and lowered bark ropes through the aperture, which were made fast to the matting that enveloped the corpse. An-a-hoots made a sign to the young men, and they began raising the body toward the opening in the roof. They always remove their dead from their houses in this manner instead of through the door, on account of a superstition they have that the spirit of the defunct made its exit in this way. But just as it arrived at the roof one of the ropes broke, precipitating the lifeless bundle upon the fire below, scattering the burning coals in every direction. For a moment all was terror, confusion, and dismay. The shrieks and yells of superstitious horror that went up from the women and children baffle description. The body was hastily snatched from the fire and hurriedly carried out through the door to the funeral pile, which was about forty yards in the rear of the house. No second attempt was made to take it through the hole in the roof, as they thought the old woman's spirit was angry and did not desire it. All the coals and ashes upon which the body had fallen were then hastily scraped up with pieces of bark by the young squaws, carried out and thrown into the sea, for fear they might bring down unheard-of evils upon the heads of the living inmates of the house.

The pyre was built of cedar logs. The foundation consisted of two logs about five feet long and ten inches in diameter, laid parallel to each other, and about two feet apart. Upon these was placed transversely a layer of shorter logs of a less diameter, with interstices between them through which the flames could penetrate from below. This base was surmounted by a small superstructure of cedar crib-work, large enough to contain the corpse and its mortuary habiliments. Into this the remains were placed and covered with small sticks of wood. Near the windward side of this pile were laid two boards, along which were ranged the singing warriors; the only office of these boards appeared to be that of furnishing a hard, resonant surface upon which the staves they used to indicate the measure of their chant could fall. Close by the crib was a pile of spruce and cedar, finely split, in order that it might burn more rapidly. The mourning relatives were seated on the ground with their backs turned toward the pyre, and about thirty feet distant. At last the torch was applied to the resinous tinder, the warriors began anew their melancholy dirge, the mourners, whose loud lamentations had before sunk to a low sobbing, now broke forth afresh into heart-rending wails. Several hours were occupied in the entire consumption of the pile, during which the chanting never ceased, but after a time the outward grief of the bereaved was confined to weeping and subdued sobs. When the fire had died out the remaining ashes and cinders were carefully collected and laid in their final resting-place.

The cinerary urn consisted of a small house built after the model of their huts, being about three feet long by two feet wide, and two high, and placed about ten or twelve feet above the ground on four posts. These dead houses are often carved and painted on the exterior in the most cabalistic manner. It was formerly the custom among these Indians to kill a number of slaves upon the occasion of the death of one of their tribe, but the military authorities of the United States have suppressed the barbarous practice since their occupation of the territory. These slaves are prisoners of war, taken from other tribes, and their bondage is hereditary. The number of slaves sacrificed depended upon the rank of the deceased.

GEOLOGY AND PALÆONTOLOGY.

Scudder on Fossil Insects from British Columbia. — A small number of fossil insects obtained by Prof. G. M. Dawson in British Columbia, from tertiary beds, have been described by Mr. Scudder in the Report of Progress for 1875–76 of the Geological Survey of Canada. The specimens are better preserved, as a general rule, than any that have been obtained from other American localities. Besides fragmentary indeterminate remains not mentioned, there are twenty-four species or more which can at least be referred to families. Beetles were, with but one exception, absent from the collection, which consisted of Hymenop-

tera (ants and ichneumons) and two-winged flies, a nitidulid beetle, a plant-louse, and a dragon fly.

BRAIN OF CORYPHODON. — In the last NATURALIST, page 312, is an abstract sent by Professor Cope, which purports to announce important discoveries recently made by himself in regard to the brain of *Coryphodon*. Reference is made to the brain of *Dinoceras* (or *Uintatherium*), and a new classification is proposed based on these discoveries. It may interest the readers of the NATURALIST to know, first, that the brain-case of *Coryphodon* was described and figured by the writer a year ago (*American Journal of Science*, vol. xi., page 426, May, 1876), and that this fact was well known to Professor Cope, although he makes no reference to it. Second, the account of the *Coryphodon* brain, given by Professor Cope, so far as it differs from my description, is not correct, and shows that he has made a most serious mistake in his observations. Third, his statements in regard to the brain of *Dinoceras* are directly refuted by a series of well-preserved specimens. Fourth, the classification based on these alleged discoveries is untenable, as the known facts are against it.

I deem it especially necessary to make these corrections, since Professor Cope has recently sent to the NATURALIST several other communications quite as incorrect as the present abstract. — O. C. MARSH.

GEOGRAPHY AND EXPLORATION.

GEOGRAPHICAL NEWS. — Herr Barth, the German explorer, surveying possessions in Africa for the government of Portugal, committed suicide in Loando while delirious with fever. Herr Mohr, another German explorer of the expedition, searching for the sources of the Congo River, is dead.

After an absence of two years in the interior of Africa, Colonel Gordon reached Cairo on his way back to England on the 1st of last December. The task assigned him was the opening of a practicable commercial highway from that city to the Albert and Victoria lakes. Sir Samuel Baker, who preceded him, had been compelled to fight his way back from the extreme point reached in the interior of Gondokoro, and had left the newly explored country in a disturbed state. Colonel Gordon has succeeded in pacifying the hostile tribes, and has established a line of posts, fifty to one hundred miles apart, from Khartoum to Gondokoro, and thence to the Albert Lake. The communication was so far perfected that English papers were received with tolerable regularity in seven weeks from their date of publication,

Four maps of the Nile from sketch surveys of General Gordon have been published in the third number of the Bulletin of the Egyptian Geographical Society. These are reproduced on a reduced scale and on a single sheet in Markham's Geographical Magazine for March. Mr. E. G. Ravenstein announces in the same magazine that he has received

from General Stone, the chief of the Egyptian staff, a map of the Nile between Dafli and the Albert Nyanza, based upon a reconnaissance made by Gordon Pasha in July, 1876. The map differs from that published previously in several respects. There is no indication now of an arm of the river flowing towards the northwest.

The Portuguese appear to exhibit an unwonted activity in connection with their African settlement. On the west coast they claim the exclusive navigation of the Congo and are charged with the design of desiring to appropriate Ambrizette, Landama, and Bandana.

At a late meeting of the Geographical Society of Paris, Mr. D. H. T. Mosse, of San Francisco, in criticising Captain Rondaire's scheme of creating an inland lake to the south of Algeria, said that the displacement of the water required to fill this lake of 6250 square miles would result in a shifting of the earth's axis! Captain Cameron gave in French at the meeting of the same society January 26th an account of his explorations. He was frequently interrupted by applause, and before separating the president announced that the gold medal of the society had been awarded to the intrepid explorer. On the 27th he was entertained at a dinner, where the bill of fare included fillet of venison *à la Kassongo*, and lobsters *à l'Africaine*.

At a recent meeting of the Geographical Society of Lyons, M. Dufonchel explained his scheme of a Saharan railway, which was to connect Algeria with Timbuktu. The Sudan had no less than fifty millions of inhabitants and a climate equal to that of Bengal or Brazil. The sands of the Sahara, it was said, would overwhelm the proposed railway, but the same thing had been said about the Suez canal, and this difficulty could be overcome by engineers. Artesian wells would furnish an ample supply of water.

At the meeting of the Geographical Society of Paris, M. Violet d'Aoust read a paper on the mountain systems of Central America and the dust whirlwinds observed by him on the plains of Mexico.

A resolution has been adopted by Congress requesting the Secretary of the Navy to transmit to the Senate the narrative of the second expedition of Captain Hall to the Arctic regions, to be compiled from notes of the expedition made by Captain Hall and purchased from his widow.

LUDLOW'S RECONNAISSANCE IN MONTANA.[1] — The route traveled by Captain Ludlow's party was an interesting one, and the account of the brief trip through the Yellowstone National Park, accompanied as it is by a map, will be valuable and authoritative to intending tourists. Mr. George B. Grinnell contributes a report on the mammals and birds, while a geological report by Edward S. Dana and Mr. Grinnell includes

[1] *Report of a Reconnaissance from Carroll, Montana Territory, on the Upper Missouri, to the Yellowstone National Park and Return, made in the Summer of* 1875. By WILLIAM LUDLOW, Capt. Engineers U. S. A. Washington, 1876. 4to, pp. 155. With three maps and two plates.

some account of the Little Rocky Mountains, a region lying north of the main route of the party. The description of new fossils, by R. P. Whitfield, is accompanied by two plates.

Recent Geographical Progress. — First and foremost we have to mention the numerous scientific congresses: the periodical sessions of the International Congress of Geographical Sciences inaugurated at Antwerp, in 1871, and continued at Paris, in 1875; the periodical sessions of the International Geodetic Association, the last session of which was held at Bruxelles, in October, 1876; the Statistical and Prehistorical Congresses at Buda-Pesth, the Congress of Orientalists at St. Petersburg, and that of Anthropologists at Jena; and, further, the creation, since 1870, of numerous geographical societies, to wit: in 1870, at Bremen; 1872, at Buda-Pesth; 1873, at Halle, Kiew, Hamburg, Bern, Amsterdam, Lyons, and Paris (Society of Commercial Geography); in 1874, at Bordeaux (Society of Commercial Geography); in 1875, at Cairo, Bukarest, and Lisbon; in 1876, at Madrid, Marseilles, at Paris (Topographical Society), at Bruxelles and at Antwerp; finally, the International Association for the purpose of suppressing the slave trade and exploring Central Africa, due to the high initiative taken by H. M. King Leopold II., and constituted at Bruxelles, September, 1876. — Bulletin No. 1, Geographical Society of Belgium.

MICROSCOPY.

Fossil Diatoms from South Australia. — Mr. Galloway C. Morris, of East Tulpehocken Street, Germantown, Philadelphia, obtained from the commissioner in charge of the South Australian exhibit at the Centennial a small supply of a most interesting diatomaceous mineral called coorongite, from the Coorong District, in South Australia, where it is found. It is a mineral of a dark-gray or ash color, a light specific gravity, and a fine spongy texture, occurring in great quantities, and consisting of about twenty per cent. of a hydrocarbon which can be separated by distillation for economical purposes as an illuminating and lubricating oil, and a residue consisting mainly of fresh-water diatoms. It burns when heated on platinum foil, is permanent in the air, and is unaffected by moisture. It is not disintegrated in ether or chloroform, though most of the oily hydrocarbon is removed. Mr. Morris has succeeded best in preparing it for the microscope by boiling it in sulphuric acid with the addition of a small quantity of bichromate of potash to make chromic acid and give off the hydrocarbon as carbonic-acid gas. He has a few slides to spare, which he is willing to exchange for other mounted specimens.

Annual Reception. — The American Microscopical Society of the city of New York held a very successful invitation exhibition at Kurtz's art gallery, Madison Square, on Tuesday evening, March 6th.

Diphtheria. — This subject has been discussed at recent meetings

of the San Francisco Microscopical Society. Dr. A. M. Edwards, who was present as a visitor, introduced the subject, describing the growth and development of the fungoid growth which is observed in connection with the disease. He confidently believed that diphtheria is at first a local disease, caused and spread by the growth of these organisms, and that salicylic acid applied in the form of spray is capable of positively arresting the disease by destroying the organisms which caused it. He believed the microscope, especially by its moderately high powers, to be the only instrument able to decide this question, and that its revelations fully sustained the theory of fungoid growths as a cause of the malady. Dr. S. M. Mouser, a member of the society, contended that the membrane was an exudation consisting of epithelial cells in various stages of formation and disintegration, mucous and pus corpuscles, and spindle-shaped bodies distributed with some regularity, indicating organization of some kind, and regarded as fibre cells or smooth muscular fibres. He had not been able to detect anything that was certainly of a fungoid character. Dr. S. Laycock, of Edinburgh, had conceived the idea in 1858 that this disease was caused by a parasitic fungus, and the theory had been revived in Germany a few years ago, and salicylic acid used to destroy the fungus, but that treatment had now been abandoned, and the local application of warm water and steam substituted for it. Aitkin, Beale, and others have considered the fungoid growths to be only accidentally present, and not a cause of the disease. The speaker believed it to be the generally received opinion of the medical profession at present that the disease is constitutional in its character, and that this theory is not disproved by microscopical observation.

Personal. — Wm. H. Walmsley, one of the best-known cultivators of microscopy in this country, retired on the first of April from the firm of Jas. W. Queen & Co., of Philadelphia. After the completion of his present European trip he expects to be able to open an American branch of "R. & J. Beck," with such a stock and at such prices as were never before seen in this country. In his new enterprise he will at least have the good will of all who have had previous dealings with him, which probably includes nearly all our microscopists.

Rock Sections. — Alexis A. Julien, of the School of Mines, Columbia College, 50th Street and 4th Avenue, New York City, is preparing to order microscopic sections of rocks, minerals, and other hard substances, and intends shortly to keep on hand series of sections of American rocks and minerals. The sections are prepared with care and judgment, and at a cost of sixty cents each except for specially large or difficult objects. If so ordered they will be mounted on the standard plate glass slides 3x1 inch, but this size is not advised on account of their thickness, $\frac{1}{16}$ inch, preventing proper illumination under high powers by achromatic condenser, inconvenient length preventing ready rotation on small stages, liability to fracture, etc. Thinner plate glass slides ($\frac{3}{64}$ to

$\frac{1}{32}$ inch) are preferred, of the size adopted by Fuess of Berlin ($1\frac{25}{32}$ by $1\frac{1}{16}$ inch), and these, with covers of medium thinness and $\frac{7}{8}$ inch square, will be used unless otherwise ordered.

A NEW STUDENTS' MICROSCOPE.—The increasing importance of cheap and portable microscopes, and the increasing demand for good instruments specially adapted to work in histology and pathology, has lately led all our prominent makers to introduce so-called students' microscopes of excellent quality and remarkable cheapness. The latest work of this kind is the new students' microscope of Mr. Joseph Zentmayer, of 147 South Fourth St., Philadelphia. This stand is a truly American model, in which the standard English and continental styles which have served as models so long, are nearly lost sight of, and the recent very important contrivances of Mr. Zentmayer are introduced almost as effectively as in his superb first class stand. The base and hollow upright column are cast in one piece, giving great lightness and firmness combined. The mirrors and substage, together, swing around the object, so that it can be readily kept in focus of the illuminating apparatus at any desired angle; and the bar can be swung so as to carry the whole illuminating apparatus above the stage for opaque objects. There is a good substage which can easily be removed entirely when desired. The stage is thin and beveled, so that extreme obliquity of illumination can be obtained by simply turning the stand or swinging the mirror. The diaphragms are mounted on the substage, and can be brought up close to the object-slide if desired. The coarse adjustment is by a sliding tube, and the fine adjustment by a screw and lever moving the whole body on a long sliding support exactly like that of the rack movement in the common Jackson stands. The stage is only three inches from the table, and the tube is correspondingly short, though capable of lengthening by draw-tube to the standard length. The whole stand is a marvel of neatness, compactness, stability, and convenience. At the request of the writer, a stand has been made with a specially adapted achromatic condenser and with a thin concentrically revolving stage like the diatom stage of the maker's "centennial" stand, which is worthy of being furnished with the highest class objectives and is capable of doing almost anything that the most elaborate stands can do.

PRACTICAL MICROSCOPY.— Rev. E. C. Bolles, an unsurpassed lecturer on the subject, has consented to give instruction in microscopy at the second session of the summer school of biology, which will be opened at the Museum of the Peabody Academy of Science, at Salem, Mass., on the 7th of July next. The term lasts seven weeks. A course of lectures and demonstrations on Animal Histology, will also be given by Mr. C. S. Minot. The admission fee is $15.00.

BOSTON MICROSCOPICAL SOCIETY.—This society held its second annual reception on Friday evening, April 27, with a programme of re-

marks by Prof. Oliver Wendell Holmes, a screen exhibition of Polariscope objects, by Rev. E. C. Bolles, and an exhibition of objects under about sixty microscopes by members of the society. The society has recently rented and furnished rooms at 29 Pemberton Square, and is working with perseverance and increasing success to unite and assist those, within its reach, who are interested in microscopical study.

SCIENTIFIC NEWS.

— The interest in geographical research continues to increase in France from year to year. The Société de Geographie of Lyons has published six numbers of its Bulletin, all full of interesting matter. A handsome volume has just been printed by this society entitled A Geographical and Statistical Study of the Production and Commerce of Cocoon Silk, by Leon Clugnet. This memoir was crowned by the Geographical Society. The president of the society is desirous of coöperating with geographers of foreign countries in popularizing the study of geography. He proposes a place for exhibiting in public places the most important geographical statistics of any desired region so that the people may read them at all times, and thus become familiar with them. The first number of the Bulletin of the Société Belgée de Geographie, published at Brussels, has just appeared. The leading article by the president, General Liagre, on Geographical Science, is one of great interest. There are seven articles with maps in this number, and a long list of members actual, honorary, and corresponding. The objects of the society, as laid down in the Bulletin, are exceedingly comprehensive, embracing every possible form of geographical information.

— The first number of the third volume of Hayden's Bulletin of the United States Geological Surveys of the Territories is rich in articles relating to the anthropology and archæology of the West, as may be seen by the following table of contents: A Calendar of the Dakota Nation, by Bvt. Lt. Col. Garrick Mallery, U. S. A. (Plate 1.) Researches in the Kjökkenmöddings and Graves of a Former Population of the Coast of Oregon, by Paul Schumacher. (Plates 2–8.) Researches in the Kjökkenmöddings of a Former Population of the Santa Barbara Islands and Adjacent Mainland, by Paul Schumacher. (Plates 9–22.) The Twana Indians of the Skokomish Reservation in Washington Territory, by Rev. M. Eells. (Plates 23–25.) Notes on a Collection of Noctuid Moths made in Colorado, in 1875, by Dr. A. S. Packard, Jr., by Aug. R. Grote. The Tineina of Colorado, by V. T. Chambers. Notes on a Collection of Tineid Moths made in Colorado, in 1875, by A. S. Packard, Jr., by V. T. Chambers. On the Distribution of Tineina in Colorado, by V. T. Chambers. New Entomostraca from Colorado, by V. T. Chambers. On a New Cave Fauna in Utah, by A. S. Packard, Jr., M. D. Description of New Phyllopod Crustacea from the West, by A. S. Packard,

Jr., M. D. On some Artesian Borings along the Line of the Union Pacific Railroad in Wyoming Territory, by F. V. Hayden. (Plate 26.)

— One of the best organized and probably the most active geological surveys in Europe is the Imperial Geological Institute at Vienna. From recent letters received from Count Marschall by Professor F. V. Hayden we glean the following items of interest: During 1876 great progress was made in the field operations in Austria and Bohemia, as well as in Southern Tyrol, Eastern Galicia, the southernmost region of the Carpathian Mountains of Galicia, and in the Triassic and Jurassic regions of the eastern Alps. Different members of the survey have made excursions to Denmark, Sweden, Northern Italy, Southern Russia (Odessa), Sicily, European Turkey, and Greece and Egypt, aided by subsidies from the government, which has most liberally encouraged the comparative study of the geology of its own empire by researches in other lands.

— The Army Signal Office has for some time past been publishing a Monthly Weather Review, in which are collected together many facts relating to the climate of the United States, which have a direct bearing upon the distribution of animal and vegetable life. We purpose from month to month to extract some of the interesting items given in this review, but must refer our readers for full information to the original which is published about the middle of each month, and quite freely distributed by the Weather Bureau at Washington.

During March, twelve areas of high pressure and twelve of low have passed over the country; all of the latter were accompanied by rain, and most of them by high winds; the most severe storm of the month was that which began on the 21st, west of the Missouri River, and disappeared on the 31st, east of Newfoundland. The month has been warmer than usual throughout the Atlantic and Pacific States, but was slightly cooler in the St. Lawrence Valley, the Lake region, Ohio, and the north west. A large excess of rain and snow fell in the lower Lake region, the St. Lawrence Valley and New England, as compared with the average for many years; a deficiency was reported from the western Gulf States, and the northwest. The temperature of the water is observed in numerous rivers and harbors, and appears to have been quite generally lower than in March of last year for the Mississippi and its tributaries, but higher along the middle and east Atlantic coasts. The chapter on Miscellaneous Phenomena contains a large number of zoölogical and botanical notes relating to the advent of spring and the birds and insects of the season. The migrations of birds are carefully reported; grasshoppers are reported as destructive in Texas, hatching in Florida, and beginning to hatch in Ohio and Kansas.

— Brehm's well-known Thierleben, a large, beautifully illustrated popular work on animals, which for many years has been the leading work of the kind in Germany, is now passing through a new edition,

enlarged, with numerous full-page illustrations and exquisite wood-cuts drawn by Kretschmer, Mützel, and Schmidt. The work is to be published in from forty to forty-five parts, of which ten have been received in this country, a part being issued every week or fortnight. The work has received the notice and praise of Darwin, Carus, Dr. Petermann, Von Tschudi, and Dr. Rohlfs. The subscription price in Germany is one mark (or about twenty-five cents). The agents for the United States are B. Westermann & Co., 524 Broadway, New York.

PROCEEDINGS OF SOCIETIES.

NATIONAL ACADEMY OF SCIENCES. Washington, April 17-20. — The following new members were elected: Elliott Coues, U. S. A., Washington, D. C.; J. W. Draper, New York; Henry Draper, New York; S. H. Scudder, Cambridge, Mass.; C. S. Peirce, Cambridge, Mass. Following are the titles of the papers on natural science: On the Young Stages of some Osseous Fishes, the Results of Deep-Sea Dredgings, by Alexander Agassiz; On Critical Periods in the History of the Earth, and their Relations to Evolution, and on the Quarternary at such a Period; On the Structure of the Crystalline Lens and its Relative Periscopism, by Joseph Le Conte; On the Structure of the Henry Mountains, by G. K. Gilbert; On the Public Domain, by J. W. Powell; Remarks on some Artesian Wells along the Line of the Union Pacific Railroad in Wyoming Territory, by F. V. Hayden.

AMERICAN PHILOSOPHICAL SOCIETY. Philadelphia, January 5, 1877. — Mr. Britton exhibited specimens of artificial fuel manufactured from the peat-bogs near Syracuse, New York, and remarked its resemblance to the lignite of southwest Arkansas. Professor Lesley read characteristic portions of a paper by Mr. Lesquereux, introductory to the Flora of the Carboniferous of North America, now in preparation for the Report of Progress of the Second Geological Survey of Pennsylvania.

January 19, 1877. — Professor Lesley presented a paper on the first systematic collection and discussion of the Venango Company Oil Wells of Western Pensylvania, by E. S. Nettleton, C. E. General Kane read a description of his recent explorations in Coahuila, exhibiting photographs of Mexicans and describing the migrations of Indians.

February 2, 1877. — Professor Cope exhibited some fragmentary crania of *Dinosauria* from the Judith River beds of Montana, and described their structural and systematic characters. He also read a paper entitled A Continuation of Researches among the Batrachia of the Coal Measures of Ohio.

February 10, 1877. — The secretary read a paper by Alexander E. Outerbridge, Jr., on the Wonderful Divisibility of Metallic Gold. Professor Lesley read a communication entitled, A Measured Section of the Palæozoic Rocks of Central Pennsylvania from the Top of the Alle-

ghany River Coal Series (on the Broad Top) down to the Trenton Limestone in the Lower or Cambro-Silurian System, by Chas. A. Ashburner. General Kane resumed the reading of his paper on the ethnological movements taking place in Northern Mexico. Professor Cope exhibited and described fragments of the fossilized skeleton of a gigantic Dinosaurian, found by Prof. J. S. Newberry, in Painted Cañon in southeastern Utah, when acting as geologist to the expedition across New Mexico to the Junction of the Green and Grand rivers under Captain McComb, U. S. A. This fossil was derived from supposed Triassic beds, and was named *Dystrophæus viæmalæ*. Professor Cope exhibited drawings of supposed Indian sculptures in the form of a dial or zodiac, said to have been recently discovered near Davenport, Iowa, in an Indian mound.

March 2, 1877. — Professor Cope exhibited the fossil skeletons of two species of *Elasmosaurus* from the cretaceous formations of the West. One of these measuring thirty-five feet in length, from the Niobrara Cretaceous of Nebraska, was regarded as representing a new species and was called *E. serpentinus*. The other, represented by seventy-six vertebra from the Fort Pierre group of Montana, was identified with the *E. orientalis*, of New Jersey. Professor Cope read a description of a new form of Proboscidian allied to *Dinotherium* and *Mastodon*, which he called *Cœnobasileus tremontigerus*.

March 10, 1877. — Professor Lesley communicated a paper entitled Notes on the Results of the Survey of the Iron Ore Beds of the Juniata District of the Geological Survey of Pennsylvania, by J. W. Dewees. Professor Cope exhibited the cast of the brain cavity of the *Coryphodon elephantopus* from the Wasatch Eocene of New Mexico, derived from the collections made by Lieut. G. M. Wheeler, U. S. A., and described its characters, which led him to the conclusion that the *Amblypoda* should be referred with the *Bunotheria* to a distinct sub-class of the Mammalia, which he called the *Protencephala*. He stated that the brains of the following genera conformed to this type: *Coryphodon*, *Uintatherium*, *Oxyæna*, *Arctocyon*.

April 6, 1877. — The secretary communicated for Dr. D. G. Brinton a paper on the Timucua Language, by Albert S. Gatschet. The secretary read a communication from Mr. C. E. Hall describing the late discoveries of *Eurypterus* in northwestern Pennsylvania by Messrs. Carll and Mansfield.

April 20, 1877. — Mr. Britton read a paper on the value of pressed peat as an article of fuel. Professor Frazer presented a paper on the cause of the northwest dip of the Mesozoic rocks in Eastern Pennsylvania, and on the origin of the magnetic and specular iron ore banks in the Mesozoic and Azoic rocks of the same region.

May 4, 1877. — Professor Cope read a paper on the structure of the brain in *Procamelus* as derived from a cast of the cavity of a skull obtained by himself near Santa Fé, while on Lieut. G. M. Wheeler's

surveying expedition. He also read a paper entitled A Synopsis of the cold blooded Vertebrata obtained by Prof. Jas. Orton in Peru, during the explorations of 1876–77. A number of species were described from the high valleys of the Andes, from 10,000 to 14,500 feet altitude.

SCIENTIFIC SERIALS.[1]

MONTHLY MICROSCOPICAL JOURNAL. — April. Additional Note on the Identity of *Navicula crassinervis*, *Frustulia saxonica*, and *N. rhomboides*, by W. H. Dallinger. The Exhibitor; a novel Apparatus for showing Diatoms, etc., by S. G. Osborne. On the Phytoptus of the Vine, by G. Briosi. A Mode of altering the Focus of a Microscope without altering the Position of either the Objective or the Object, by M. Gori.

THE GEOLOGICAL MAGAZINE. — April. What is a Brachiopod? by T. Davidson. Notes on the Geology of the Lebanon, by E. R. Lewis. Ettinshausen's Theory of Development of Vegetation on the Earth.

ANNALES DES SCIENCES NATURELLES. — February 15th. Anatomie de la Moule commune (*Mytilus edulis*), par A. Sabatier. (Nine Plates.)

ANNALS AND MAGAZINE OF NATURAL HISTORY. — April. On the Distribution of Birds in North Russia, by J. A. H. Brown. Description of some Sponges obtained during a Cruise of the Steam Yacht "Argo" in the Caribbean and Neighboring Seas, by T. Higgin. Hermaphroditism in the parasitic Isopoda, Further Remarks on Mr. Bullar's Papers on the above subject, by H. N. Moseley.

ARCHIV FÜR NATURGESCHICHTE. — Jahrgang 43, Heft 1. Ueber den Bau des Bojanus' schen Organes der Teichmuschel, von H. A. Griesbach. Ueber das Eierlegen einiger Locustiden, von Dr. Bertkau.

POPULAR SCIENCE REVIEW. — London, April. Evidences of the Age of Ice, by H. Woodward. On the Desmids and Diatoms simple Cells, by G. C. Wallich. The Norwegian Lemming and its Migrations, by W. D. Crotch. The Alkaline and Boracic Lakes of California, by J. A. Phillips.

APPALACHIA. — March. Geology of the White Mountains (with Map of the White Mountain District, showing Locations of specimens and contour Lines for each 500 feet above the sea), by C. H. Hitchcock. Carter Dome and Vicinity, by W. G. Nowell. Distant Points visible from Mount Washington, by W. H. Pickering. Application of Photography to Mountain Surveys, by J. B. Henck, Jr. The Flowering Plants of the White Mountains, by J. H. Huntington.

THE GEOGRAPHICAL MAGAZINE. — April. The Arctic Sledge Journals (Map). Chile. The River Purûs in its Commercial and Geographical Relations to the Valley of the Madeira (with Map of Purûs and Madeira Rivers), by E. G. Ravenstein. Indian Marine Surveys.

[1] The articles enumerated under this head will be for the most part selected.

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NOTES ON THE AGE AND THE STRUCTURE OF THE SEVERAL MOUNTAIN AXES IN THE NEIGHBORHOOD OF CUMBERLAND GAP.

BY N. S. SHALER.

The dogma of De Beaumont as to the parallelism of mountain chains of the same age has not lost its effect on the minds of geologists. The exceeding ability and untiring persistency with which its fallacies were urged has made it necessary to do more than refute them. Every instance of distinct contradiction should be well attended to and brought to the attention of naturalists. Having been trained in the theory of De Beaumont, I confess to having held to some remnant of faith in his views until I began my studies on the Appalachian system of mountains. Having examined this system in a preliminary way, throughout its extension from Gaspé to Georgia, I am convinced that as far as we can base our conclusions on the structure of one mountain system, it would be nearer the truth to say that mountain systems are more likely to be the product of parallel upheavals occurring in successive geological periods than of single epochs of elevation.

Some years ago I called attention to the fact that the Cincinnati axis was an outlier of the Appalachian system, and that it was formed, in part at least, as far back as the calciform sand rock of the Upper Cambrian period; also that the syenite axis on which Richmond, Virginia, now stands was uplifted after the general elevation of the Alleghanies had taken place,[1] since the formation of the Richmond coal-basin, and therefore must be referred to a time subsequent to the Trias if not to the Lias. The Blue Ridge was certainly elevated, at least in part, before

[1] I have since found that the parallelism of the Cincinnati axis with the Appalachian system had been previously noticed by Prof. J. M. Safford, State Geologist of Tennessee.

the formation of the Appalachian coal-field, so that the east and west section, from the Mississippi River to the sea across the Appalachian mountain system, gives us evidence of four distinct periods of elevation, the separation of which is recognizable on even a cursory inspection. I was not prepared, however, to find the additional evidence of the succession of elevations which has been given me by the study of the region lying between the Unaka Mountains of North Carolina and Central Kentucky. The work of the Kentucky Geological Survey in connection with the Harvard Summer School of Geology ranged during the last two summers over this area. As the results of this exploration must wait, it may be, some years before publication, I shall summarize some of the most important points that bear on this question.

The geologist who is accustomed to the aspect of the Alleghanies in Pennsylvania will be struck with the change in the appearance of their continuation in East Tennessee. In place of the long-drawn symmetrical arches of the Pennsylvania section, we have here in East Tennessee a great irregular table-land crossed from north to south by narrow wall-like ridges, which have, in some cases, a length of over one hundred miles. A close study of the country shows that these ridges are in most cases the more or less retreated walls of fault lines, which have a singular directness in their course and uniformity in the depth of their throw.

The increase in the amount of faulting that took place in the formation of the Alleghany Mountains south of Pennsylvania becomes perceptible as we pass the Potomac River. In the mountainous regions of Virginia, along the waters of the south fork of that river, it begins to mark itself on the topography, and the change continually increases as we pass toward East Tennessee. Although still much in doubt as to the nature of the influences which have brought about this change, I venture to suggest the following explanation, which seems in a measure to satisfy the conditions of the problem.

On looking at the sections exposed in Southwestern Virginia and Eastern Tennessee, it will be seen that there are two classes of ridges found in this district: one formed by faults and the other by escarpments of the retreating crest of the anticlinals. It will be seen that the fault ridges have been formed on either side of the anticlinal ridges, though there is but one considerable ridge formed in this manner on the western side, while there

are three or more on the eastern side. After a good deal of consideration of these peculiar features, I have come to the conclusion that this change of the structure on the southward extension of the Alleghanies can best be accounted for by assuming the following conditions: First. That in place of the relatively narrow ridges of the Pennsylvania district, the uplifts which occurred here took the shape of one or more very broad anticlinals having a transverse width of sixty miles or more. Second. That each of these anticlinal axes was fractured by faults along several lines for its whole length, the result being to tumble the fissured strata over each other, leaving only the central part of the anticlinal still complete. Third. That the more massive the Blue Ridge to the eastward becomes, the more intense do we find this faulting action, on the east showing some relation between this faulting and the mass of the old mountains. I have long been of the opinion that the faulting in any mountain region becomes greater as the anticlinals widen or tend to take on some of the characters of the Alpine "massifs." It is not difficult to imagine a reason for this general occurrence of faults in broad folds of mountain masses; a small fold may have some sustaining power to its arch, and can await the gradual movement of strata to fill up its suddenly formed cavities. A broad fold will necessarily be weaker; the creeping of the strata into positions fitted to sustain the uplifted ridge may not be quick enough to keep furrows from forming, as they have formed in this Tennessee district.

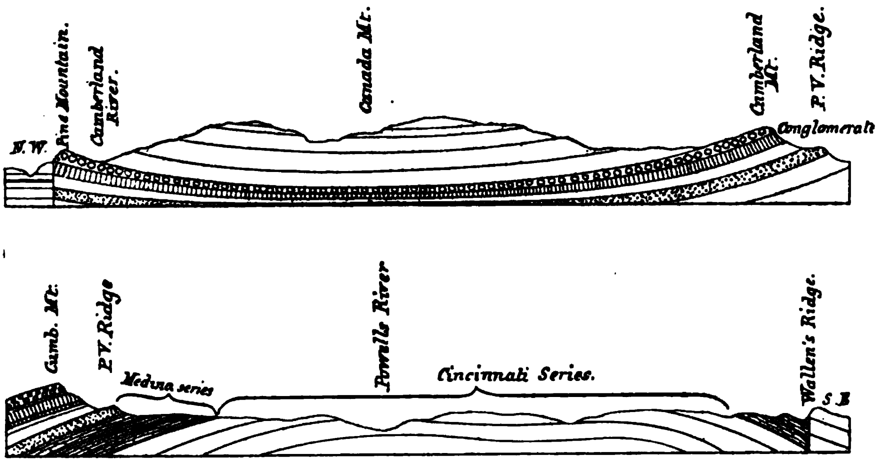
It is not so easy to perceive a reason for the greater width of the anticlinals in this part of the Appalachian chain. There are, however, good mechanical reasons why the width of the ridges and furrows which make up a mountain range should have a width proportionate to the depth of the strata involved in the movement. An illustrative experiment showing the principle that determines this is easily made by taking a number of sheets of heavy paper and compressing them from the sides. The more sheets we affect by the pressure, the broader the resulting folds will be.

In any region where successive mountain upheavals have taken place, as in the Alps, there is often evidence going to show that the lateral force operated at first to disturb the more superficial beds, and then in succession the deeper ones became affected. It is this, I believe, that gives us the Swiss *massife* plan of mountain-building. I conceive that in the Alpine region there was first a set of folds after the essential plan of the Jura Mount-

ains, then at a succeeding time there was an upheaval that affected a deeper set of beds and formed far wider folds, on which the earlier uplifts were upborne as the lesser waves of the sea upon the greater ridges. At the same time the broader folds were much faulted, so that the whole mass became exceedingly complicated in its structure. The Appalachian system, in its extremely varied yet comparatively simple conditions, presents us with a number of peculiar connections and separations of these two classes of folds. The Cincinnati axis, for instance, is a sample of the broad fold of the simplest character. This fold seems to have been lifted with extreme slowness, and has a height of only a few hundred feet, being certainly not over fifteen hundred feet in height at any part measured from the bottom of the synclinal to the top of the ridge. But notwithstanding the slow formation and moderate elevation of this fold it has been somewhat affected by faulting in a direction transverse .to its axis; these faults are, however, relatively very small. It seems to me that the East Tennessee region has had its form given by an effort to produce very broad and long anticlinals somewhat on the Cincinnati model, but of far greater height. One of these ridges, the Cumberland anticlinal, if it had retained its form, would have had a length exceeding one hundred and fifty miles, a width of sixty miles, and a height exceeding twelve thousand feet. The parallel faults reduced its height to less than half this height, and left an indistinct central anticlinal and a set of parallel fault mountains, one on the west, and four or more on its easterh side. According to the theory of De Beaumont these several mountain ridges, the central anticlinal and its several parallel monoclinal or fault-mountains, should have been of the same age, the product of a single cataclysm. The evidence, however, has led myself and my assistants of the Summer School of Geology and the Kentucky Survey, who have studied this country, to a very different conclusion. We have been forced to the conviction that the central anticlinal is of relatively ancient age, dating back primarily to a time soon after the expiration of the carboniferous time, while the other monoclinal mountains have been more or less gradually formed, some having been uplifted at a geologically very recent date. This succession has been determined by the only means we have of fixing the age of neighboring parallel faults in a region of this description, namely, by comparing the rate of the escarpments formed by the several fractures. The central escarpments, as will be seen from the accompanying figure, there covering the

anticlinal, have gone back as much as six or eight miles from the top of the arch, while the lateral escarpment of Pine Mountain has not retreated more than half a mile from its original place. After making all due allowance for possible differences in erosion rate of the two forces, it will be impossible to believe that erosion has acted on these two faces for equal lengths of time. There can be no doubt left in the mind of any one who studies these escarpments and satisfies himself of their relation to the geology of the neighboring districts, that their outcrops were made at periods widely remote from each other.

If there should be any need of accumulating proofs on this point, they could be found in a number of other circumstances



(FIG. 70.) DIAGRAMMATIC SECTION ACROSS THE CUMBERLAND SYN-ANTICLINAL.

connected with them. The Pine Mountain fault, for instance, is characterized by a wonderfully rectilinear front, being hardly swerved from a straight line in fifty miles of its length. Throughout this distance the fault that made the escarpment is hardly half a mile from the summit of the crest. The Cumberland Mountain, which is an anticlinal escarpment, is an exceedingly irregular line, often departing as much as a mile from a direct course, and cut through and through at many points by streams. These irregularities in the one case and the regularity in the other attest the difference in the age of the two escarpments. There is still other evidence, the nature of which, however, it is not easy to make plain in a few words. This evidence may be briefly stated as follows: The streams on the west which head against the Pine Mountain are generally characterized by a

singularly low rate of fall; in several cases they run for miles without the least contact with their bed rocks, in fact with many feet of alluvial strata between their beds and the rock in which their troughs are excavated. I have been unable to explain this peculiarity save on the supposition that the district through which these streams course has been somewhat lowered by the movements which formed the Pine Mountain fault. If this be really the case, then we are compelled to suppose that the later movements of this dislocation — if the dislocation has indeed been, as I am disposed to believe, the product of a series of movements, — must have taken place after the drainage of this country had been entirely established, when each crest ran on its present line. I am led to the opinion, all the evidence being taken into account, only a part of which I can discuss here, that the escarpment of the Pine Mountain fault is now retreating from the line of breakage at the rate of not less than one foot in one hundred years. The rocks comprising the abrupt declivity are of a generally perishable nature and wear out readily under the action of frost and rain. This rate of retreat would give an age of not over five hundred thousand to one million and a half of years as the time that has elapsed since the formation of this fault. I am quite well satisfied that this estimate for the antiquity of the Pine Mountain fault is far within the truth, that it is in fact the result of disturbances which came in the time of the later Tertiaries.

I hope to elaborate these observations on the conditions of the Alleghany system in the Memoirs of the Kentucky Geological Survey; at present it is only possible to set forth the evidence in the briefest manner, with the special aim of calling the attention of students of physical geology to the evidences of recent action in the mountain-building forces in this part of the Appalachian district. I am confident that, more than any other mountain action known to me, they tend to show that the strains which are relieved by mountain folds and faults are, in certain cases at least, continuous actions leading from time to time to movements that afford relief thereto. No one can study the structure of the section between the eastern face of the North Carolina mountains and the western side of the Cincinnati axis without being driven to the hypothesis that in a geological sense the mountains contained therein have been in a process of continuous formation since the beginning of the lowermost Cambrian deposits. Perhaps less distinctly shown, but it seems to me quite clear, is the evidence

that the relief of these mountain-building barriers has been found in two ways: First, by the folding of the earth into ridges and valleys, or synclinals and anticlinals; second, by the forming of faults which are the product of the rupturing of the folds, and must be regarded as resulting from the failure of the lower lying rocks to follow and support the more superficial beds in their upheaval. This failure may have been in part caused by the exceeding width of the upthrown ridge, which could not maintain itself until the deeper beds could adjust themselves to support it.

When we consider the numerous cases in this district where the drainage crosses faults of many thousand feet of throw, we are driven to the belief that whole geological periods have been required for the movements involved in their formation. I am inclined to believe, however, that while the greater part of these dislocations have been made slowly, some of them have been formed with a great suddenness, and attended by movements of extreme violence. Besides the faults traversed by streams whose courses have not been turned or interrupted by these gigantic dislocations there are others which exhibit unequivocal evidence of violent movement in their formation. These evidences are various in their nature, but they are most conspicuous in the shattering of the walls on either side of the fault. The best instance of this sort of disturbance is found about the fault which passes through Cumberland Gap, and by the weakness it has given to the rocks has brought about the formation of this mountain pass. This remarkable fault is marked by the presence of a belt of rock fifty feet or more in width, which has been fractured into a breccia by the violence of the movements which have attended its formation. The breccia is cemented by an infiltration of iron derived from the adjacent carboniferous series of rocks. A careful study of this breccia has convinced me that the fault is the product of many successive movements, though each of them must have been attended by a certain beating of the walls against each other. This fault, it should be noticed, is transverse to the direction of the great faults in this system of mountains, and is limited to the Cumberland synclinal, extending from a little beyond Cumberland Gap on the east to the gap in the Pine Mountain at Pineville. It differs also from the great parallel northeast and southwest faults which we find at Clinch Mountain, Mound Hill, and other points, in the irregularity of its throw, which differs not only in amount but in direction in a curiously irregular way. I believe that it owes its formation to the com-

pression strains which take place in the synclinal fold of the Cumberland. It is readily to be perceived that the nature of the strains developed by the synclinal folds must vary greatly from those which are formed beneath the anticlinals of a mountain district.

I only propose to call attention to the great problems in structural geology which this region presents to us, with a view of interesting our students of dynamic geology in their solution. More extended discussions of these questions will be given in the forthcoming volumes of the Memoirs of the Kentucky Geological Survey.

THE STUDY OF ZOÖLOGY IN GERMANY.

BY CHARLES SEDGWICK MINOT.

II. THE METHODS USED IN HISTOLOGY AND EMBRYOLOGY.

The use of the microscope goes hand in hand with the work of zoölogists in Germany, and it is there that we find the greatest number of means employed to render the objects suitable for examination. I have frequently heard American zoölogists express a slight distrust of histological methods, — well founded, perhaps; it ought not to lead to the rejection of the benefits to be obtained from using them, but merely to greater caution in employing them.

It is well known that animal tissues and organs consist of cells of various kinds, variously grouped together. The forms which these cells can assume lead to the most curious transformations, so that things as different from one another as muscular fibres, blood corpuscles, and ganglion cells can be traced as modifications of the same primitive form. The work of microscopic anatomists is to detect the changes which the simple cells of embryos undergo in the course of their transformations into the components of the tissues of the adult, and to investigate in detail the final results of these metamorphoses. It is much to be desired that America should assist more in this work, and it is with the hope of stimulating some persons to do so that this article is written.

In the tissues of the adult we find the cells arranged in a definite manner, and we have consequently to examine the shape and character of the single cells, and then their relation to one another. Simply placing a small piece of an organ underneath

the microscope is not sufficient to enable us to do this, but we are obliged in every case to subject the preparation to a special treatment. The first thing to be done is to make the object transparent enough to let the light pass through it to the objective, which is usually done by mounting it in glycerine or in Canada balsam, both of which substances have a high index of refraction, and therefore when they penetrate the interstices of a tissue do away with the refraction inside of it, so to speak; for in every tissue the different parts refract the light so variously that a ray passing through frequently changes its path, thus confusing the final image which reaches the observer's eye. A layer of powdered glass lets the light pass through, but nothing distinct can be seen; if, however, the whole is immersed in Canada balsam, it immediately becomes beautifully transparent, because the balsam fills up the spaces between the bits of glass, and since balsam and glass refract light to about the same degree the mass becomes optically nearly uniform, and a ray of light can pass through it without being deviated from its course or destroying the image. The action on the tissues is identical, — and this should be carefully remembered, because balsam renders objects more transparent than does glycerine, so that in some cases one liquid is better than the other. It is a sign of inexperience to assert that balsam is better than glycerine, or *vice versa*, for they are both useful, but for different purposes.

In order to observe the cells well it is necessary not to have too many superposed layers in the field of view, but to make the object as thin as possible. This is usually accomplished by making sections. So important and so useful are such very thin slices that probably nine tenths of every histological collection consist of them. The first thing, therefore, is to acquire skill in making sections, and the perfection reached will mainly decide how far the progress of the student shall continue. The importance and benefits of making sections have led to the invention of a great many mechanical contrivances for cutting them. One form of cutter or microtome well adapted to its object was described in the April number of the NATURALIST of this year. Numerous other forms have been suggested, but those with which I am acquainted all have some defects. Free-hand cutting still remains absolutely indispensable. It may be acquired by patient practice even by those who have no special manual skill, just as we are all able to write. There are many things which cannot be cut with a machine. The razor for cutting should be

of the best quality, and when used always drawn towards the body, while the surface, which looks downward in cutting, must be flat. The edge must be perfect, the slightest notch being sufficient to tear a section to pieces, and so sharp that a human hair can be split with it. The sections themselves must be as thin as possible.

Since all parts of the body, with few exceptions, such as the skeleton, etc., are soft and permeated by water, besides possessing great elasticity, they cannot be cut in their natural condition; it becomes necessary, therefore, to harden the organs. Now protoplasm is the main constituent of cells, and itself consists chiefly of albumen. This substance can be coagulated by the action of various agents, some of which can be applied to the tissues without injuring them, to produce a coägulation of the albumen in its natural form within the cells.

Alcohol is one of the most valuable agents for this use. It produces its effect by its strong affinity for water, which it can withdraw from the tissue, thus causing the albumen, which requires an abundance of water to maintain its semi-fluid state, to solidify. It may be employed for the majority of tissues with perfect success. The volume of alcohol should be from twenty to thirty times that of the object to be hardened; weaker alcohol, say of eighty per cent., should be used first; after a sojourn of an hour or two, or even longer, if large, the object may be transferred to stronger (ninety-six per cent.) spirit and there left for twenty-four hours, more or less, according to the size of the piece. The great difficulty in the use of alcohol is to prevent the shrinkage which naturally follows upon the abstraction of the water from the tissues. This may be avoided by using first weak, and then strong, and finally very strong spirit. In some cases the action is not even then sufficient, and recourse must be had to absolute alcohol, which generally produces the desired result.

When even that does not succeed the specimens may be put in picric acid (concentrated cold aqueous solution) for twenty-four hours, then in a syrupy solution of gum arabic for twenty-four hours, and finally in strong alcohol again for the same length of time. The picric acid removes the alcohol, and allows the gum to penetrate the object, within which it is finally coagulated by the last dose of spirit. The sections when made must be left in water for a day, to dissolve out the gum which they still contain, and which renders them quite opaque. A very few

drops of strong carbolic acid may be added to the water to prevent the development of bacteria, etc., which would quickly ruin the preparations. Coagulated gum renders the majority of organs of a pleasant consistency for cutting.

Instead of gum, paraffine may be made to permeate the tissues, in the way already described in detail in the article on the sledge microtome, in the April NATURALIST.

All acids produce in albumen chemical changes, which, without withdrawing the water, cause coagulation. There are some which are admirably suited for hardening agents. Foremost among these is chromic acid, first introduced by Hannover, in 1841, from motives of economy. It is employed in solutions of two fifth parts for one thousand parts water. Very large quantities must be used,—weak solutions at first to be gradually replaced by stronger and stronger ones. If its action is kept up too long the objects become brittle and are then worthless, for every section crumbles to pieces as soon as made. Chromic acid is particularly useful in studying nervous tissues, organs of sense, and other unusually delicate tissues. Its action is very slow: thus the spinal cord of a large dog or a man requires at least six weeks or two months. Chromic acid is also admirable for preparing very young and frail embryos or eggs. There are many other agents which are sometimes used for hardening, but it is not deemed appropriate to enumerate here any but the two principal and most useful ones, alcohol and chromic acid.

After the proper degree of hardness has been produced, if the piece to be cut is large enough, it may be held in one hand and cut with the other without more ado. When, however, we have to deal with something too small and delicate to be held in the hand, it is necessary to have recourse to some method of imbedding. Paraffine will usually be found the most convenient substance for this purpose, especially when mixed with one tenth of its weight of the best hog's lard. The most satisfactory process of imbedding in paraffine we have elsewhere described.[1]

On some accounts transparent soap is to be highly recommended. The best quality, containing *no glycerine*, must be chosen, then shaved into small bits, and warmed with half its volume of alcohol (as compared with it before it was cut up) until it is entirely dissolved; the specimen to be imbedded is then suspended in the warm mass by a fine thread and left for

[1] April NATURALIST, 1877, page 208.

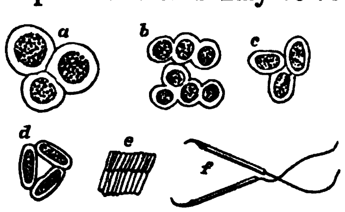
twenty-four hours. The soap does not become hard until the alcohol evaporates from it; the less alcohol, therefore, put in originally, the better. The soap ought to remain perfectly clear, enabling one to see the imbedded specimen within, so that it can easily be observed exactly in what plane every section is made, which is not possible when paraffine or wax is used. The sections, when made, if cut in soap, must be put in alcohol, if from paraffine, in spirits of turpentine, to dissolve out the remains of the imbedding mass.

If now the sections, after being thus freed from the adherent foreign matter, be mounted directly, they make poor preparations; the single parts are indistinct, and the whole is very transparent. This can be avoided by coloring them. It may be safely asserted that the introduction of staining fluids, by Gerlach, in 1858, was the most important step in advance ever yet made in histological technic. Coloring matters, as regards their action on cells, belong to two classes: either they produce a diffuse coloring of the whole cell, or they stain the nucleus much more deeply than the protoplasm and the membrane of the cell. The principal are dyes of the latter class, carmine, hæmatoxiline, and aniline blue, which are esteemed in the order named. The two former are invaluable, for by marking out the nuclei so distinctly they enable us to recognize so many centres of cells, and to observe characters which have been made prominent by their coloration, and are very different in the various forms of cells. In fact, preparations for the microscope cannot be felt or dissected, but only seen; therefore, the differential coloring produced by carmine, for example, is an assistance to the eye, comparable to the raised alphabets of the blind. In both cases, the conditions under which the special sense, whether sight or feeling, has to act are greatly exaggerated, so to speak, thus producing magnified or strengthened perceptions.

Carmine is by far the most generally useful. It is employed in various solutions, the recipes for which may be found in various hand-books, and need not, therefore, be quoted in this article. The first step in preparing it is to dissolve some of the fine-powdered carmine in a small quantity of ammonia, and it may be used at once in that form after allowing the superfluous ammonia almost entirely to evaporate. A very excellent solution may be prepared by simply adding an equal volume of rather strong acetic acid to the dissolved carmine; the exact proportion is not of very great import. Beale's carmine keeps a long time

without alteration, and Ranvier's picrocarmine has certain advantages; but on the whole, I have found the above-mentioned mixture of acetic acid and ammoniacal carmine to be quite sufficient for most work.

Hæmatoxiline, on the other hand, has to be employed in a particular solution. Dissolve first thirty-five parts of hæmatoxiline crystals in one thousand parts of absolute alcohol, and mix it cold with a solution of ten parts alum in three thousand parts distilled water. The mixture is purple at first but turns a deep blue in the course of a few weeks; but it may be used without waiting for the change of color. For use it must always be filtered through porous paper to free it from sediment, and it may be advantageously diluted with 0.5 per cent. solution of alum. It acts much more quickly and produces a deeper and more exclusive staining of the nuclei than does carmine. It is therefore particularly applicable in those cases where it is desired to study the shape and transformations of nuclei, as, for example, in tracing the development of spermatozoa. A figure is here added to show how beautifully the changes can be followed in sections of the testicle of *Epicrium glutinosum*, one of the Cœciliadæ or footless, worm-like amphibians. The testicle is divided up into numerous follicles, and the cells in each are all in one stage, while the various follicles present various degrees of development; thus in a single section all the principal alterations may be observed. The cells (Figure 71) are round at first with a very large granular nucleus (*a*). They then divide, becoming smaller and more numerous (*b*). The next change is a slightly irregular elongation of cell and its nucleus, slight at first (*c*), but gradually increasing (*d*).



(FIG. 71.) DEVELOPMENT OF THE SPERMATOZOA OF EPICRIUM GLUTINOSUM.

At this point in the metamorphosis the protoplasm is gathered at one end of the cell, and the long nucleus at the other, and it at once becomes evident that the nucleus is to make the head of the spermatozoön, the protoplasm the tail. At this stage the cells lay themselves in rows (*e*), the nuclear ends, or as we may now call them the heads of the young spermatozoa, all pointing the same way. Each cell continues to elongate until it grows into a fully developed spermatozoön (*f*), with a pointed front end, a long head which appears almost black when stained with hæmatoxiline, and a long, fine tail. The development of the

spermatozoa seems to be very much the same in all vertebrates; that is to say, the primitive cells of the testicular follicles divide into smaller cells, and the nuclei of these make the heads, while their protoplasm changes into the tails of the spermatozoa. We have spoken of these changes here because it is proposed that the next paper shall be on the development and early stages of eggs, and there will be occasion to refer to the observations just quoted.

It is well known that cells create certain products which appear outside of the cells themselves; thus wherever there is a layer of cells having a free surface, as, for example, the outside of the body of invertebrates or the walls of tubes such as ducts of glands, the digestive canal, etc., they tend to form a structureless membrane, which stretching over them all acts as a common protective covering. The hard crust of insects is such a membrane or *cuticula*, and a corresponding one lines the tracheæ and the stomach, etc., of insects and many other animals. Now the application of section-making to the study of *cuticular* growths reveals many interesting peculiarities; as this study is only just entered upon, it is hoped that a reference to some of the results may prove valuable.

M. Léon Dufour described curiously shaped teeth in the crop of certain crickets, especially well developed in the mole-crickets, very large also in the katydids. Herr Wilde, of Leipzig, has made a very thorough study of these teeth and their development; he kindly showed the author many of his preparations, and explained his results. He made numerous beautiful sections of the crops of several species, both young and adult. Figure 72 is taken from one of his sections of the crop of *Gryllus cinereus*, the European field cricket. There are six teeth of very irregular shape, with many protuberances, but presenting, nevertheless, the general outline of a triangle, with the apex towards the middle. On each side of the projecting apex are two protruding points, at the base of which there is a bundle of stiff chitinous bristles.

(FIG. 72.) TRANSVERSE SECTION OF THE CROP OF GRYLLUS CINEREUS.

Between every two of these gigantic teeth there is a small ridge (*r*) which also has a hard cuticula. Further, the teeth are not

attached along their whole base, but are partly drawn back, so that there is a space (*sp*) between the middle of the base and the muscular walls of the crop. The teeth form six regular, longitudinal rows, numbering each about twenty teeth. Their form varies according to the genera, and probably also according to the species. The walls of the crop are built up mainly of circular muscular fibres (*muc*) which by their contraction drive the teeth towards the centre and so grind up the food of the cricket, thus performing a function which we are wont to think of as properly belonging to the mouth. The study of the development of the teeth enabled Herr Wilde to ascertain that they are formed by underlying cells through a series of transformations of the cuticula, which appears at first as a simple membrane and then develops the secondary projections, which give the teeth their ultimate form. All these interesting discoveries could hardly have been made except by means of sections.

The author has himself applied section-making to the study of the tracheæ of insects.[1] It was found that the current descriptions in works on comparative anatomy and entomology were incorrect in several important particulars. The outside of the trachea is covered by a layer of flat polygonal cells, or, as it is called, a pavement epithelium. Thus in a longitudinal section of the main tracheal stem of the common water-beetle, *Hydrophilus* (Figure 73), the thin cells (*ep*) may be easily recognized by their nuclei. The epithelium secretes the enormously thick and complicated cuticula (*cu*) which makes up the rest of the tracheal wall. The well-known spiral threads or filaments *ff* are part of this cuticula, and not distinct structures as was generally supposed. These threads run around the tubes and serve as elastic supports to keep the thin walls distended; they are more or less spiral, but instead of there being but one single thread, as is usually stated, there are four or five which end, after making a few turns around the tracheæ, new ones arising to replace them. As the fibres run transversely, of course their cut ends only are seen in a longitudinal section like Figure 73. But these ends show that the filaments consist of a lighter outside, and a darker inside portion, which latter is round. The rest of the cuticula (*cu*) is divided into two layers,

(Fig. 73.) Longitudinal section of the trachea of Hydrophilus piceus.

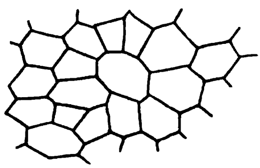
[1] Minot, Recherches histologiques sur les Trachées de l'Hydrophilus piceus. Arch. de Physiol. normale et pathologique, sér. ii., tom. iii., page 1.

the inside or right hand one in the cut, being slightly colored by carmine, while the outside layer is hardly stained at all. This affords another excellent illustration of the ease with which valuable discoveries may be made, when well-known histological methods are applied to the study of insects ; indeed, insects offer a rich and easily accessible field of research, promising perhaps greater rewards in proportion to the necessary labor than almost any other department of zoölogical investigation.

It would be easy to add illustration after illustration to those already given, but it is not our purpose to review the progress of histology, but merely to give incentives to work in that field. We pass on, therefore, to a few additional considerations on the "technique" of preparing tissues for microscopical examination. Experience has shown that it is very difficult to distinguish the single cells in sections, in some case almost or quite impossible; or it is even impossible occasionally to make any sections at all. On these accounts various means are employed either to isolate a few cells or to mark the outlines of them. The methods hitherto employed for these purposes are few in number and limited in application, but they have already led to interesting observations.

Many cavities of the body, both of vertebrates and lower animals, are lined by a layer of flat cells that are separated by lines of intercellular substance; by treating such a surface suitably with certain silver salts the intercellular lines are colored dark brown or black. A solution of one part of nitrate of silver in five hundred parts of distilled water (by weight) is very convenient. It gives beautiful preparations when applied to the mesentery of a rabbit, for example. The mesentery is the thin membrane by which the intestine is suspended from the back of the abdomen. Cut out a small piece from a freshly killed animal, a frog or rabbit or any other vertebrate, and place it in a silver solution, where the direct rays of the sun can fall upon it, and move it about with a glass rod (metal would be corroded) so that all parts may be equally acted upon ; next remove it for a moment into distilled water to wash off the silver, and then spread it out on a glass slide and let it dry almost completely, taking great pains to stretch it out by pulling it at various points so that it shall dry *fully* extended. Before it is quite dry put on a drop of glycerine and a thin glass cover in the usual way. If the impregnation has been successful, the lines will appear very sharply, as in Figure 74, which is from the mes-

entery of a turtle. If the impregnation was not sufficient the lines do not appear, but that is also the case if it has been too prolonged, for then the cells fall off altogether. The membrane may be colored with hæmatoxiline or carmine, if so desired, after impregnation, and then the stained nuclei appear within the dark outlines making exceedingly pretty preparations.



(FIG. 74.) MESENTERY OF TURTLE. SURFACE IMPREGNATED WITH SILVER.

Maceration gives the means of isolating layers of cells. If the skin of an amphibian, a toad, for example, be pinned out on a bit of cork and then placed in a dish of water containing three or four drops of strong carbolic acid to prevent the development of germs, and then left for a day or two, the superficial layer of cells may be peeled off with a pair of pincers, and so on, successive layers from day to day until the whole skin has been removed. The bits thus peeled off usually contain but a single layer of cells, and if colored with carmine they make very beautiful preparations.

But besides investigating cells in their relation to one another, the histologist endeavors to determine the form of single cells, and employs therefor means of isolation or dissociation. These may be either mechanical, such as shaking up a tissue in a fluid or teasing it out with fine needles, etc., or chemical. Usually a combination of the two is the most effectual.

In most tissues the cells are united by intercellular matter, just as above described in the epithelium of the mesentery. This substance acts as a cement binding the cells together. In some cases it reaches an extraordinary development, so that the cells come to be quite far apart, as in cartilage, for instance. But usually it is very thin, and may be dissolved, in some cases, without altering the appearance of the neighboring cells. The cells that line the intestine and stomach are particularly adapted to illustrate this action of certain chemicals. Thus if a small bit of the wall of the digestive canal be left in alcohol of thirty per cent. for twenty-four hours, the lining cells all become loosened so that they are easily scraped off with a needle or scalpel, and if mounted in glycerine mixed with a little picrocarmine, they become stained in a week or so, and show the details of structure of the single cells very admirably.

Chromic acid has a similar action, and solutions of two parts in ten thousand of distilled water have a great value from their so

affecting the brain that the ganglion cells may be quite easily isolated. To effect this a very small piece of the brain — calf's brain is perhaps the best — is placed in fifty or sixty times its volume of the solution for twenty-four hours, and then carefully teased out under a good dissecting microscope.

Both weak chromic acid and alcohol may be used for isolating muscular fibres. Flies and beetles are perhaps the best for this purpose. The muscles of the wings (not those of the legs) should be torn out with fine forceps, and little bits, the smaller the better, placed in thirty per cent. spirit for twenty-four hours, and then dissociated or pulled apart on a glass slide, with fine needles. With sufficient care it is possible to separate the single fibrillæ of each fibre, and when stained with hæmatoxiline the alternating lines, dark and light (Figure 75), appear very sharply. These lines are those that make the muscles transversely striated. The cause of this striated appearance is not yet fully determined, but it is apparently connected with greater perfection of the muscular fibre than is found in the unstriated form. Different as is muscle in appearance from cells yet it originates from them, and is in fact formed of metamorphosed cells, by a series of changes all as great as those which produce bone.

(FIG. 75.) ISOLATED MUSCULAR FIBRE OF COMMON WATER BEETLE.

We have still to notice a very important class of procedures, namely, injections. In the higher animals we find two distinct sets of vessels ramifying through the whole body: one of these is the system of blood-vessels, the other the lymphatic system. As is well known to all, the blood-vessels branch out into very fine tubes that form a complicated net-work in every part of the body, so fine that it can only be followed when the tubes or capillaries have been artificially filled with a colored matter. The same is true of the lymph-vessels, but to an even greater extent. Many of the structures of the body are permeated by connective tissue, and in this tissue there are numerous cavities filled with fluid; they are in communication with very delicate tubes, the lymphatic capillaries, which soon unite into larger canals, and these form branches which gradually join together and lead to the thoracic duct or main stem, which empties into the veins just before they open into the heart. The branches of this tubular system are provided with valves so arranged that the liquid contained in the tubes can only pass upward or towards the main stem. Now when any

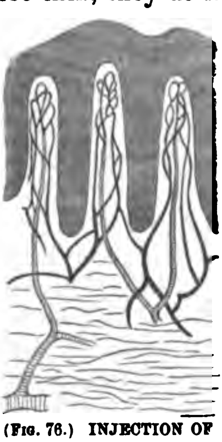
motion takes place, some of the liquid in the cavities of the connective tissue is pressed into the lymphatics and so slowly driven onwards into the heart. To counterbalance this loss of intercellular fluid, certain constituents of the blood exude through the walls of the capillaries and keep up the supply. There is, therefore, a double circulation: one within the blood-vessels, and another from the walls of the capillaries through the lymphatics. The liquid in both circulations is ultimately returned to the heart.

Different methods have to be employed for injecting the two systems. In the case of the blood-vessels a rather large syringe may be used, provided with a point small enough to pass into the artery of the part to be injected. The artery should be carefully laid bare and cut about half way through; the point of the syringe, which must be previously filled with the injection mass, is pushed into the artery and firmly tied in place. In many cases it is quite sufficient to inject a cold saturated solution of Prussian blue in water, or when more perfect preparations are wanted, a little gelatine may be added; in this case, however, there arises the inconvenience that both the injection mass and the organ to be injected have to be kept warm while the operation is going on, otherwise the gelatine solidifies.

To prepare a "warm" injection mass, the following method is, perhaps, the best. A solution of Prussian blue is necessary; this the histologist must make for himself. To do this take a concentrated solution of sulphate of protoxide of iron in distilled water, and pour it slowly into a concentrated solution of yellow prussiate of potassium; a precipitate of insoluble Prussian blue is formed. There should be a small excess of prussiate at the end of the operation, to test which take out a drop and add to it a little of the sulphate. If there is any free prussiate still present, a blue precipitate is thrown down. Filter through a felt strainer, below which a funnel with a paper filter has been placed. Pour water on to the strainer in small quantities at a time, and continue filtering; this operation must be kept up for several days, until the liquid below the second filter appears distinctly blue. The matter on the felt strainer is then removed and dissolved in distilled water. This solution is admirable for cold injections or for filling the lymph-vessels, as will be described presently. There should always remain an excess of blue in the vessel in order to be sure that the solution is saturated; as the solution is removed it may be replaced by dis-

tilled water, as long as there is any blue left. To make the "warm" injection mass take twenty-five parts of the Prussian-blue solution and one part gelatine. The latter must be of the finest quality, as otherwise it produces a granular precipitate which renders it useless for histological purposes. Put the gelatine to soak for half an hour in distilled water, then remove and wash it; place it in a glass vessel and warm it in a water-bath, when it will melt in the water it has absorbed. The Prussian blue is put in another vessel in the same water-bath, so that the two liquids are at the same temperature. Pour the gelatine, little by little, into the blue, stirring constantly with a glass rod. Keep on warming and stirring until the granular precipitate formed at first disappears. Upon being filtered through a piece of clean flannel, the mass is ready for use.

It requires only to be slightly warmed to become liquid, and the organ to be injected does not need to be heated to so high a temperature as is necessary in using many other injection masses; there is, therefore, no danger of injuring the tissues by subjecting them to too high a temperature. The injection should be continued until a little while after the mass begins to come out through the veins, in order to allow all the capillaries time to fill themselves. When the injection is finished, the organ may be placed to advantage for twenty-four hours in a 2 to 1000 solution of bichromate of potassium in distilled water, and then be removed to alcohol; or it may be put at once in alcohol, and, when hardened, sections made of it. The sections should be pretty thick, and may or may not be stained as is desired. If too thin, they do not show the connections of the vessels.


(FIG. 76.) INJECTION OF HUMAN LIP.

As an example of the clearness with which the blood-vessels may be traced in a successful preparation, a figure of a section through an injected human lip is given (Figure 76). The shaded portion represents the skin proper, and is penetrated by papillæ sent up from the underlying connective tissue, known in anatomy as the cutis, and carrying the blood-vessels. There is a net-work of small arteries in the cutis, and from this there pass up from three to five fine branches into each papilla, and form by division and inter-communication a wide capillary network. One or several fine capillaries bend

round and form the veinlet which passes down the middle of the papilla, from top to bottom, in a nearly straight line, and sometimes taking up fine branches on the way until it finally connects with the venous net-work of the cutis.

This arrangement of the vessels is very characteristic; similar ones occur elsewhere, where there are well-developed papillæ, as, for instance, on the tongue or in the intestine. But each organ presents characteristic peculiarities in the distribution of its blood-vessels, and to an experienced histologist the veins, capillaries, and arteries of the liver and kidney, etc., are as distinctive of each organ as is its general shape and appearance.

As the presence of the valves does not permit us to inject the lymphatics from a large stem in the finer branches, as in the blood-vessels, a different method of forcing in the fluid has to be adopted. A small syringe with a very fine sharp point, such as is known among instrument-makers as a hypodermic syringe, must be used. The point is made to penetrate in the connective tissue, and the colored liquid — the best is a solution of Prussian blue — is forced out slowly and gently, and fills at first the cavities of the tissue and then the small lymphatics. These injections are difficult to make and by no means always succeed well. Perhaps the best place to try first is the interdigital web of the hind-foot of a frog, or the outer half, that is, the muscular part of the walls of the small intestine; but the easiest of all to fill are the lymphatics of the dog's testicles. When the injection has been once made in the way indicated, the tissue or organ may be hardened for cutting either in chromic acid or in alcohol.

Such, then, are some of the principal means employed to investigate the microscopical structure of animals. They all have this much in common, that they are endeavors to render certain characters more visible than they are naturally. This we do whether we stain the nucleus, or inject the blood-vessels, or isolate single cells. It may well be added that a good knowledge of optics is necessary to a good histologist.

The worker should also remember that American instruments are usually much less convenient and practical than the German and French microscopes, while the lenses are no better, though enormously more expensive. The writer personally likes Zeiss's instruments very much. As this optician manufactures his objectives upon mathematical principles, he is able to make them all nearly alike; but it must be understood that there are many others whose objectives are also of the best quality. At present

there is no difficulty in getting the best lenses and instruments, providing an American or English microscope of large size and complicated structure is not chosen. It will be found that those only who use a microscope for amusement utterly condemn the simple instruments, while those who make investigations and gather wide experience often assert that the greater the simplicity the better. The European histologists I have met generally use a stand without rack and pinion for coarse adjustment, without movable stage and without movement round a horizontal axis.

As to books, Frey's Manual, of which there has been a translation published in New York, is only pretty good. It came into general use because it was for a long time without rivals. There have lately appeared two little works on this subject, in England, one by Professor Rutherford, the other by Mr. Schaeffer, both of which are considered good. But by far the most important work is Ranvier's Traité Technique d'Histologie now being published in Paris, in numbers, three of which have already appeared. The moderate price of the book, — only twenty-five francs for a volume of a thousand pages, — the fullness of detail, and the superb illustrations alone are sufficient to recommend the work. M. Ranvier has written a treatise which will probably always be remembered as one of the most important and valuable manuals ever published, and which ought to be owned by every one who attempts to investigate the elementary structure of animals.

CONCERNING FOOT-PRINTS.

BY I. C. RUSSELL.

ICHNOLOGY (foot-print lore) is the name which has been applied to one of the most attractive and interesting paths of research that geology has pointed out. This branch of palæontology[1] has for its object the study and interpretation of the many fossil foot-prints that have been found in the rocks, which were impressed there by the feet of animals when the material of which those rocks are composed was the shifting sands along some ancient shore. The study of foot-prints has at length been recognized as a distinct and important branch of palæontology, one which has often afforded the only means for judging of the character and structure of the ancient animals that have left no other records of their existence than the impressions of their feet.

[1] From palaios, *ancient;* onta, *beings;* logos, *a discourse.*

The same principles of comparative anatomy that enabled Cuvier to reconstruct the skeletons of Tertiary mammals, a few bones of which were discovered near Paris, also give the ichnologist the power of calling again into being the forms of the animals which in times long passed impressed their foot-prints on the sand.

Let us see, first of all, how the records of these ancient footsteps have been preserved for indefinite ages, so as to appear as fresh and well defined as if made but yesterday. It is evident that if a track is left in the loose dry sand, it is poorly defined and soon becomes obliterated; but if impressed on the wet sand at low tide, or on mud of the proper consistence, it may retain its form for a considerable time. The first and most common means by which such foot-prints are indefinitely preserved is by the rising tide filling and covering the impressions with the mud and sand borne on by the advancing waves. Each tide by depositing a sheet of sediment over the trodden surface would not only tend to bury the foot-prints deeper and deeper and thus secure their preservation, but the new deposit thus spread out by the waters might receive a series of records in its turn, made by the feet of the birds and reptiles that walked over it, and by the drops of rain that pattered down on the plastic surface, or by the retreating wavelets that rippled over the soft mud. Such inscriptions when once entered on the day-book of nature are imperishable until the rocky tablets that they form are again ground down to sand and dust in the great cycle of changes to which they are subjected.

Such preservation of foot-prints can nowhere be better seen than on the shores of the Bay of Fundy, where, owing to the great difference between high and low tide, — in some places amounting to seventy feet, — a broad extent of smooth, shining mud is left exposed at low water. Some portion of this soft surface is sure to be trodden by the numerous birds that feed along the shore, or to have its surface pitted by a passing shower; often, too, the mud is left in regular ripples by the retreating tide, and sometimes a leaf is borne out by the wind and dropped on the plastic surface, to record the character of the vegetation that fringes the shore. The red mud with all these inscriptions upon it is somewhat hardened by the warmth of the sun, so that it retains its place when the advancing tide rushes in. As the waters then sift down the fine mud which they hold in suspension, it fills each foot-print and rain-drop impression, and imprisons the leaves that are fast on the bottom; and thus is finished

another page in the records of the ages. When the tide steals slowly out, this deposit of silt is left behind with a smooth, glossy surface as before, ready to receive another series of impressions. This is not a rare or exceptional occurrence, but takes place nearly every summer's day on the shores of the great bay.

The constant accumulation of mud left in this manner by the retreating tides, although a single deposit may not exceed a sheet of paper in thickness, has yet formed thousands of acres of rich meadow-land, like the Tantramarsh and the broad meadows of Grand Pré, which retain, beneath their waving fields, the records made in the manner we have described, during hundreds and perhaps thousands of years before the Acadian farmers made that land their home. Sometimes upon splitting open the layers of hardened mud that form these meadows, the impressions made by the feet of animals are found; often, too, the bones of fishes are thus discovered, showing the manner in which the remains of the fishes that once swam in Devonian and Carboniferous seas have been preserved to our own day.

Another series of markings that are well displayed on the shores of the Bay of Fundy, and which are commonly associated with fossil foot-prints, are the shrinkage-cracks (or mud-cracks and sun-cracks, as they are often called) formed by the shrinking and cracking of the mud upon drying, when left exposed to the heat of the sun, — exactly as may be seen in every dried-up pool by the wayside. Such a net-work of intersecting fissures frequently covers many acres of the mud on the shores of the Bay of Fundy; and these modern mud-cracks often intersect and distort the foot-prints that have been previously formed, in precisely the same manner as the ancient foot-prints were sometimes distorted in the Triassic sandstone of the Connecticut valley.

The discovery of the stumps of pines and beeches rooted in what was once the surface of the soil, but now buried beneath the muddy deposits of the bay, prove, as pointed out by Professor Dawson, that the land has subsided and allowed the deposits to reach a greater thickness than they could otherwise have done. We can learn from this submerged forest a lesson that will be of value to us in all our geological rambles. It furnishes one of the many indications that the crust of our globe is not the *terra firma* it has been fancied to be, but is slowly rising in one place and sinking in another, and is sometimes pushed up into great folds from which mountains are formed. Recent research has shown that for hundreds of miles along the coast of Chili, the

land is slowly rising; a similar movement is taking place in Northern Europe; while, on the other hand, areas of equally great extent in some portions of the Indian and Pacific oceans are slowly sinking. That a gradual subsidence and an equally gradual deposition have together determined the mode in which great thicknesses of sediments have accumulated during many of the geological ages is clearly shown by the formations that contain from base to summit the indisputable evidences of shallow water origin.

The material that is continually deposited by the waters of the Bay of Fundy is furnished, for the most part, by the wearing away of the rocks along the shores of the bay. This process can nowhere be better seen than at the picturesque promontory at Hopewell, situated at the head of Shepody Bay. The Carboniferous conglomerate there forms a bold headland, which is being rapidly eaten away by the waves at high tide, so as to make one of the most interesting bits of coast scenery that we ever had the pleasure of seeing. The waves have not only worn the hard conglomerate into many dark caves and ragged capes, but have also cut out high archways, forming natural bridges that connect outstanding masses of rock with the shore. In some cases these bridges are wanting or have been washed away; and what were once bold headlands are now separated from the shore, but still bear on their summits a crown of trees and shrubs that were once continuous with the vegetation on the mainland. The masses of rock thus separated from the shore — frequently calling to mind the outstanding "buttes" along the Green River, and in other cañons of the far West — form islands at high tide, and are worn away at their base by the action of the waves, so that each is supported by a constantly diminishing column of stone, which at length gives way, and brings down the huge mass into the reach of the waves, which fast reduce it to sand and mud, to be spread out once more by the waters. The pebbles that compose the conglomerate, after being imprisoned in the rock for unknown ages, are again rolled up and down the beach as they were in the Carboniferous days when they received their form. We were interested to observe the ripple-marks on the coarse rocks, made when they were the loose sand and pebbles on the shore of the Carboniferous ocean, only a few inches from the similar forms impressed upon the soft mud by the retreat of the morning's tide. So exactly alike were the ripples in each case that a person could with difficulty appreciate the fact that one

series was formed millions of years before the other. The system of denudation and deposition so well illustrated at Hopewell Cape also furnishes a striking example of one of the most universal and far-reaching causes for the "imperfections of the geological record."

Another way in which foot-prints are preserved for long periods of time is by becoming filled with the fine sand and dust borne along by the wind, which by being drifted into the tracks penetrates their finest markings, and becoming covered with more blown sand, or by silt at high tide, retain, as already explained, an accurate mold and cast of the foot-prints, when the material shall have been hardened into rock. A counterpart of this second method of preservation can be seen when the newly fallen snow is drifted along by the wind and fills each cranny and crevice in the pavement; the snow gradually accumulates above, representing the sediment sifted down over the foot-prints on the shore, and sometimes becomes frozen into a solid mass, which when removed from the walks retains on its under surface an accurate cast of every line and crack on the stones beneath.

Still a third mode in which the impressions made by the feet of animals may be permanently preserved is seen when they are filled with fine sand and silt brought down by streams during sudden floods. The muddy waters then spread broadly out over the trodden sands, and cover them with a layer of fine mud; or, again, such a sheet of sediment may itself receive the impressions and be covered with sand by the incoming tide.

Layers of sand and clay when once deposited not only tend to become consolidated by the pressure of the mass that goes on forming above them, but are also penetrated by water bearing silica, lime, etc., in solution, which by being deposited around the particles of sand cement them together so as to form a compact sandstone; the strata of mud and clay may form at the same time beds of slade. Sandstones and shales being exposed to a high temperature or subjected to great pressure, are further metamorphosed and form quartzite and argillite, or the common slate used in the school-room. Throughout all these changes, however, the rocks sometimes retain the forms impressed upon them when they were soft sand and mud.

The oldest tracks known — excepting, perhaps, the trails left by annelid-like animals on the Taconic rocks of Vermont — were discovered some twenty-five years since in the Potsdam sandstone

at Beauharnois, Canada, situated about twenty miles westward of Montreal. These foot-prints were made a subject of study by Professor Owen, and were considered by him as having been formed by a large crustacean, resembling very closely in structure the *Limulus*, or "king-crab," so common along the Atlantic coast

(Fig. 77.) PROTICHNITES SEPTEMNOTATUS, O. Potsdam.

(Fig. 78) CLIMACTICHNITES. Potsdam.

at the present day. The tracks consist of a medial furrow, accompanied on both sides by a large number of small indentations. The entire series of impressions is about six inches wide, and has been followed in some cases for several feet. It will be noticed that the tracks on each side of the medial line have a definite rotation and form separate groups which regularly succeed one another, — each of these sets of impressions in the trail represented above being formed by seven individual tracks on each side of the furrow. From the nature of the impressions and the regularity with which they succeed each other, we conclude that they were made by an animal having either seven individual legs on each side of the body, or else a fewer number of limbs which were divided at their extremities; the latter theory is the one that Professor Owen considered most probable. The modern Limulus, whose trail resembles these ancient foot-prints almost exactly, has five pairs of true legs, four of which are forked at their extremities, while the hindmost pair is terminated by four lamellar appendages. The rigid tail of the Limulus leaves a furrow on the sand over which the animal walks corresponding to the central furrow in the trails on the Potsdam sandstone. That this ancient furrow was also made by a rigid tail, and not by the under surface of the animal's body, is shown by the fact that when a sharp curve was followed, the medial furrow swept to one side and sometimes obliterated the foot-prints on the convex side of the trail.

Several series of foot-prints of the same general nature as

those shown in Figure 77 have been discovered at Beauharnois and at other localities in Canada; to all of these the generic name of *Protichnites* (*earliest foot-prints*) has been given. These trails differ among themselves, however, principally in regard to the number of individual tracks in the successive series of impressions. Some of the trails have seven separate indentations in each corresponding series, and are hence designated as *Protichnites septem-notatus*; others with eight impressions in each group, making sixteen as formed by all of the feet of the animal at the same time, are known as *P. octo-notatus*; others have received the name of *P. multi-notatus.* When we remember the great antiquity of these foot-prints, their discovery is seen to be of peculiar interest. The Potsdam sandstone on which they were impressed forms the base of the Silurian system in this country, and is almost the oldest formation in which well-defined fossils have been found. If we attempt to enumerate the centuries that have passed away since these delicate foot-prints were traced upon the sandy shore of the old Silurian ocean, we find ourselves as totally bewildered by the almost infinite lapse of time as we are when we endeavor to comprehend the distance of the fixed stars in space.

Splendid specimens of *Protichnites* can be seen at Montreal, in the rooms of the Geological Survey of Canada, to whose former director, Sir William Logan, we owe our knowledge of these interesting fossils. No one can examine those slabs of sandstone, with the strange trails sweeping across them, without some of that feeling of mingled wonder and awe which creeps over us when we see the inscriptions of some ancient people regarding whom tradition is silent.

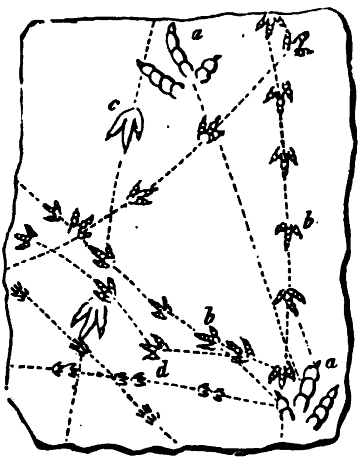
These trails are not only interesting from their great antiquity, but also because they afford the only records ever discovered of the animals that made them. We find in the rocks that have afforded these foot-prints a few fossil sea-weeds, which mark the humble commencement of the flora of the globe, the shells of the Lingula, which are quite abundant at some localities and are the most common fossils from this formation, and also a few shells of other brachiopods, and some equally rare specimens of gasteropod shells. These lowly forms of life, together with a few species of trilobites, some of which, however, reached a very large size, make up the scanty fauna of those early days. None of the animals in this brief list could have left trails on the sand at all similar to those known as *Protichnites*, which owe their im-

pression to some unknown crustacean of a higher degree of organization than any of the animals we have enumerated, which was literally the king-crab along the shores where it made its home.

The Potsdam sandstone has also yielded another series of foot-prints fully as large as *Protichnites*, called *Climactichnites*, in reference to their striking resemblance to a rope-ladder. These impressions (Figure 78) consist of two furrows, about six inches apart, the interspace crossed by parallel curved furrows that represent the rounds of the rope-ladder; there are also indications of a medial furrow, as in *Protichnites*. Of the animal that formed these trails even less is known, as can be inferred, than of those whose tracks we have been considering. They are supposed by some persons to be the track left by a huge trilobite, like *Paradoxides Harlani;* others consider them as the trail of a large gasteropod, no other records of which are known. Although the trail known as *Climactichnites* differs greatly in appearance from *Protichnites*, yet it is not impossible that they were formed by the same animal under different conditions: one impressed upon the sands while walking, the other, perhaps, formed by the swimming appendages, which are supposed to have resembled those of the Limulus.

As we have seen, the crustaceans were the highest forms of life in the Silurian oceans; their reign was terminated, however, about the close of the upper Silurian, by the introduction of fishes, which continued to be the rulers of the ocean throughout the Devonian age, which, for this reason, is often spoken of as the age of fishes. Another great advance was made in the life of the globe during the Carboniferous age, when the air-breathing reptiles first came upon the stage of being. The existence of these more highly organized animals in the Carboniferous age was first made known by the discovery of their foot-prints. The honor of first bringing these interesting relics to the notice of geologists is due also to Sir William Logan, who discovered reptilian foot-prints on slabs of Carboniferous sandstone in 1841, at Horton Bluff, Nova Scotia. Shortly afterwards, the well-known discovery of the foot-prints of a large amphibian, named *Sauropus primævus*, was made at Pottsville, Pa. For some time the foot prints of these ancient reptiles were the only evidence known of their existence. These scanty records, however, were enough to demonstrate that lizard-like reptiles, of considerable size and of a high organization, existed during the age in which the coal deposits of Nova Scotia and Pennsylvania were formed.

After a time the skeletons of some of the Carboniferous reptiles were brought to light. One of the earliest and most interesting of these discoveries was made by Lyell and Dawson, while examining the stump of a Sigillaria, one of the most common trees of the coal swamps, which had been buried in the sand that now forms the thick beds of sandstone at the South Joggins, Nova Scotia. The stump in question seems to have rotted away in the interior during the time when it was partially buried in the sand, so as to form a convenient retreat for the reptiles that made it their home, and in which they died as they were entrapped by the sand, which at length filled the stump and preserved the remains. Other skeletons of Carboniferous reptiles have since been discovered in considerable abundance at Linton, Ohio. A careful study of these remains has shown that there was no lack of diversity or of ornamentation and beauty among the reptiles that recorded their existence on the sands of the Carboniferous sea-shore, the authenticity of which has been so abundantly verified.



(FIG. 79.) SLAB OF TRIASSIC SANDSTONE WITH TRACKS OF BIRDS AND REPTILES.

In the Triassic period, which next succeeds the Carboniferous age in geological history, another great advance was made in the progress of life on the earth by the appearance of birds, which, as a class, stand next above the reptiles in the zoölogical scale. The existence of the feathered tribes during the Triassic period was first made known by the discovery of their foot-prints in the red sandstone of the Connecticut valley.

The Triassic formation in which these impressions were found fills the greater part of the Connecticut valley, and is again largely developed in New Jersey, affording in that State the red shales and sandstones so well known to travelers over the various railroads that radiate from Jersey City. It is this formation that furnishes the "brown stone" so largely used for architectural purposes in New York and the neighboring cities. The same formation stretches southward as far as Virginia and North Carolina, where it contains highly valuable beds of coal.

The foot-prints found so abundantly in the Connecticut valley frequently seem to have been impressed upon a layer of soft mud, now shale, and to have been covered with a layer of sand, now hardened into a firm sandstone, which, upon being raised from its native bed, retains upon its under surface, standing out in relief, an exact cast of the foot-prints. These natural casts are often as perfect as if molded in plaster, and sometimes retain even the lines and creases of the skin which covered the feet of the animals that impressed them. These tracks have not been found in a few rare instances, but number many thousands, obtained from nearly forty localities in the valley of the Connecticut; the writer has also obtained several species from Pompton and Plainfield, N. J.

We commonly hear these fossil foot-prints spoken of as "bird tracks;" they include, however, very many that are clearly reptilian in their character. Others have been referred to marsupial animals by Professor Hitchcock, to whose splendid report on the Ichnology of Massachusetts we would refer our readers for detailed and accurate information on this subject.

No skeletons of these ancient inhabitants of Connecticut and New Jersey have been found sufficiently well preserved to substantiate the conclusion of geologists that many of the tracks were made by birds, as the class is at present defined. Some persons are inclined to ascribe the bird tracks to kangaroo-like reptiles, which walked on two legs, like the gigantic *Hadrosaurus* that inhabited the shores of New Jersey in the next succeeding age, — the Cretaceous. Some fortunate discovery of the skeletons of these animals will possibly show that they possessed something of that strange "synthetic structure" so often met with in geological history. It is not improbable that these earliest of birds possessed a combination of reptilian and avian characters, exemplified by the *Archæopteryx*,[1] the *Pterodactyls*,[2] and the toothed birds from the Cretaceous formations of Nebraska.

The principal reasons that have led geologists to consider many of the Connecticut foot-prints as having been made by birds are that the animals were clearly bipeds, and left a tridactylous, or three-toed, impression on the mud; some of them had a fourth

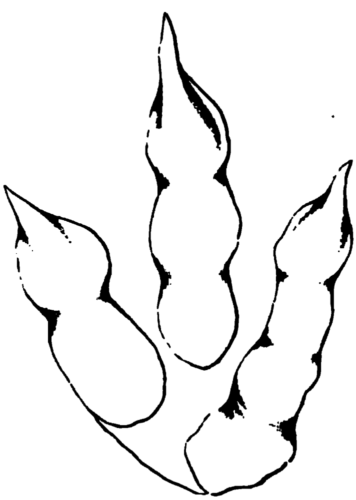
[1] A fossil bird found at Solenhofen, Bavaria, having short, rounded wings with claws attached, and a long lizard-like tail, composed of about twenty vertebræ, each supporting a pair of quill-feathers.

[2] A genus of flying reptiles belonging to the Jurassic and Cretaceous ages, which possessed membraneous, bat-like wings, that sometimes measured twenty-five feet from tip to tip.

toe, connected with the metatarsal bone above the foot (as in many modern birds), which sometimes left a slight impression on the trodden surface. But the most striking analogy between the ancient tracks and the foot-prints of modern birds is to be seen in the fact that the phalanges, or joints of the toes, have the same numerical ratio in each; that is, in three-toed birds the inner toe has three, the middle one four, and the outermost one five phalanges.

The force of these arguments in favor of the ornithic character of the foot-prints has been somewhat impaired by the discovery of tracks bearing these peculiarities, but having, also, in connection with the large tridactylous impressions of the hind feet the much smaller five-toed tracks formed by the fore feet of the same animal, showing that they were made by a reptile. Sometimes a medial furrow accompanies such tracks, indicating that the animal possessed a long, strong tail. These discoveries, although proving that there have been three-toed reptiles, yet by no means prove that all the "bird tracks" were formed by such animals.

We learn from the Triassic foot-prints that the strange creatures that impressed them not only inhabited the Eastern States in great numbers, but also that there was great variety in that ancient fauna.



(FIG. 80.) BRONTOZOUM GIGANTEUM TRIASSIC.

The accompanying figure of the foot-print known as *Brontozoum giganteum*, from Professor Hitchcock's report, represents the largest of the bird-like tracks found in the Connecticut valley. The foot-print represented in the figure as two and one half inches in length is in fact eighteen inches long and a foot in breadth, indicating, not only from the size of the foot-print, but from the manner in which the trodden surface was crushed down, and also by the length of the stride that separates the steps, a bird of gigantic proportions, that must have far surpassed in size the largest of living birds, — although probably not exceeding the dimensions of the *Dinornis giganteus*, which at no very distant time inhabited New Zealand.

"The giant ruler of the valley," however, was the great *Otozoum*, a huge biped reptile, whose foot-prints were each twenty inches in length by sixteen inches in breadth, and separated by strides three feet long; its great weight pressed down the sands as if an elephant had walked over them. Together with these gigantic foot-prints are found the tracks of other and much smaller denizens of the shore. The smallest of the Triassic reptiles, as indicated by its track, could not have exceeded a common frog in size. Associated with these are found the trails of worms and curious markings supposed to have been made by the fins of fishes, which we know inhabited the waters in great numbers.

The smooth, glossy surfaces of the slabs bearing the foot-prints have often received other inscriptions which are scarcely less interesting than the records of animal life. Frequently the surface of the rock is pitted with impressions made by falling rain-drops, and we can even tell the direction from which the wind blew during the time that those ancient showers watered the earth. The ripple-marks plainly tell that the soft mud was covered with water, which then, as now, broke in ripples on the beach. The sun-cracks no less clearly prove that the wet mud was left exposed to the heat of the sun, which caused it to shrink and crack, and that the surface was again covered with water which filled the cracks with sand and thus secured their preservation. These combined records show that the tide ebbed and flowed along those ancient shores, and that when it was at its lowest, it left exposed a broad stretch of shining mud, like that which borders the Bay of Fundy at low tide; upon this plastic surface the strange, uncouth monsters that emerged from the deep impressed the imperishable records of their existence.

We will leave to our readers the pleasure of picturing the strange scenes that filled the valley of the Connecticut in those distant days, when conifers, cycads, and ferns of tropical growth formed a varied and beautiful border to the valley and furnished shelter and food for the singular creatures whose footsteps we have followed.

To those who would drink deeper of this "foot-print lore," we recommend the writings of Hitchcock, Deane, Lea, Owen, etc.; or, still better than all, to pry open the leaves of the ancient tile library of nature, and interpret for themselves the cuniform impressions with which they are inscribed.

EXPERIMENTS ON THE SENSE-ORGANS OF INSECTS.

BY A. S. PACKARD, JR.

THE interesting experiments of Mr. Trouvelot, described in the April NATURALIST, which it should here be explained were in my hands eight years before their final publication, the MS. having been overlooked, led me to make similar experiments, which are offered here with the hope of stimulating some more competent observer to work up the subject in a more complete and scientific way.

From a worker honey bee (*Apis mellifica*) I removed one antenna. It flew with difficulty and acted as if much hurt. On removing the other, except the first and second joints of both antennæ, it appeared to be semi-paralyzed, and on being tossed up in the air fell helpless to the floor, and did not at first walk about much, but in two or three minutes recovered sufficiently from the shock of the amputation to walk, though it had apparently lost the power of coördination and also the power of stinging; but it soon recovered its strength enough to fly a little, and began to dart out its sting, but most of the time it buzzed about on the table on its back. After four or five minutes it came to, and flew with a comparatively steady flight to the window on being thrown up in the air. It then walked up the window-pane.

On removing the stumps of both antennæ it was partially paralyzed, and dropped repeatedly on the floor upon being thrown up in the air. It did not regain its wits as soon as before, but remained on the window-sill walking about, not climbing up the pane. It, however, had the power of partially coördinating its steps, and would now and then clean its feelers (palpi) by drawing them through its jaws. It would not sting me even on pressure with the finger. Fifteen minutes afterwards it had not recovered the power of flying, and in essaying flight would fall on its side, buzz about on its back, and then walk staggering along. The movements of the mouth-parts were not affected. One hour after deantennization it would remain motionless, and on violently tapping the window-sill on which it rested it would not stir, but on touching it slightly it moved a little, and soon became motionless; after this a still heavier tap would slightly startle it. Upon depositing a drop of dissolved sugar within a line of its head it did not notice it; on daubing it over the end of the

stump of the antennæ no movement was made by the bee, but as soon as the fluid had spread and moistened the mouth-parts it unbent its maxillæ and vigorously lapped it up, the tongue (lingua) playing back and forth between the maxillæ as the latter spread open a little. During this operation I held the bee between my fingers; it did not sting me, but soon thrust the sting partly into the skin of my finger, showing that the power of stinging had partially returned.

This experiment seems to show that the sense of hearing may reside in the antennæ of the honey bee, while that of smell has its seat in the palpi (and perhaps the tongue) alone. It would also seem as if the antennal nerves were so continuous with the supraœsophageal ganglia that they are as it were part of the brain, their removal at a little distance from their origin producing such a shock to the ganglionic nervous system that the insect acts somewhat like a bird on being deprived of the cerebral hemispheres, while the special senses in the organs left untouched are not affected. The bee was more profoundly impressed by the mutilation than other insects, as will be seen by the following experiments, and this is evidence in favor of the view that the Hymenoptera and the honey bees especially, stand at the head of the insect creation.

On removing the antennæ from a species of *Andrena*, a common wild bee, it immediately fell on its back as if stunned, and lay on its side curled up as though hurt, and on letting it fall would drop down and lie still on the table, not trying to use its wings. It laid several hours on its back and then died. On the other hand a smaller species, about half the size of the other, on being treated in the same manner did not seem to be much affected, as it walked about in its usual lively fashion on the table and finally flew out of doors. A small *Halictus* and *Augochlora* bee, after the loss of their antennæ, flew with a little less directness and freedom, but showed no signs of being hurt. A humble bee (*Bombus Virginica*) and wasp (*Vespa maculata*) on being deantennized acted in much the same manner; on being thrown up in the air they would repeatedly fly to the window, not being stunned as in the honey bee, though they were somewhat affected, occasionally falling over on to their backs and remaining there several minutes. A second wasp of the same species acted in the same manner after the same style of treatment. On placing dissolved sugar on the stumps of both antennæ, no impression was made upon it, though when put to its

mouth it eagerly lapped the sweet. Finally the wasp flew out of the window.

I removed the palpi or feelers from a female *Polistes* wasp, leaving the stumps of the maxillary palpi. It did not eat the sugar with its usual heartiness, but still extended its tongue slightly. One experiment like this proves nothing, but suggests that the sense of smell or taste probably resides in the tongue and base of the maxillæ of these insects as well as in the palpi.

A female blue mud dauber (*Pelopæus cœruleus*) on removal of the antennæ showed no less activity than before and flew and ran about in its ordinary manner.

A large blue-black ichneumon-fly on removal of the antennæ was not affected much. On placing a lump of sugar at its mouth it eagerly lapped it, but on removing both pairs of palpi, leaving short stumps, it did not lap the sugar, though I repeatedly put it close to its tongue and actually plastered the solution on the tongue. I also put the insect into a cup with a solid mass of sugar at the bottom, but it did not eat it, having apparently entirely lost the sense of taste. In this insect it would seem as if the sense of taste resided in the ends of the palpi. Previous to their excision they moved very briskly while the ichneumon was lapping the sugar with its tongue.

In walking up the side of the glass as well as on the table it felt its way in a peculiar tentative manner with its left fore leg, the short stumps of its antennæ all the while moving, showing that the antennæ rather than the eyes are used in walking, and that when deprived of its antennæ and eyes it uses one leg like a blind man his stick to feel its way.

An ichneumon of another species on removal of its antennæ and of the labial and the terminal half of the maxillary palpi, lapped sweetened water.

A small *Microgaster*, on partial removal of the palpi, leaving only the stumps, acted like the larger ichneumons.

A small brown ant on losing its antennæ was at first evidently much shocked, turning round and round in a confused manner, but in a minute or two it walked off nearly as well as ever. It found its way to the rim of a goblet and lapped the sugar solution with its tongue, the maxillary palpi being extended straight backwards. It cleaned its fore legs, drawing them through the maxillæ.

A number of butterflies and moths were experimented upon. On removal of its antennæ a *Papilio Asterias* flew irregularly to

the floor, remaining there; on opening the window it flew out heavily, having evidently lost some of its powers of flight and of directing the movements of its wings. It remained just where it had settled in the path from four P. M. until after nine o'clock the next morning. Then on putting it in a sunny place it disappeared five minutes after, and must have become warmed and flown away.

A *Colias Philodice* on removal of its antennæ did not fly quite so readily as one in the same room unmutilated, but the difference was not marked; two deantennized *Pieris rapæ* behaved in the same manner as the *Colias.*

An *Argynnis Idalia* in losing its antennæ seemed but slightly affected, but showed more of a tendency to drop to the floor than if in a natural condition. On putting sweetened water on the ends of the stumps of the antennæ, in a minute it partly but not wholly unrolled its maxillæ. On moistening the ends of the labial palpi no effect was produced; on moistening the base and ends of the maxillæ they at once unrolled and felt about for the sweet object with their tips, and on putting a drop of sweetened water on the window frame in front of it, it eagerly lapped it with the maxillæ, and on losing the place of the drop it felt around until it found it and then again lapped it. This experiment tends to show that both the sense of taste and touch must reside in the maxillæ of the Lepidoptera, and not in the palpi.

On removing the antennæ of a *Deilephila lineata* which had just come from the chrysalis, it seemed to fly more vigorously than before, and to be rendered more restless in its motions. On snipping off the antennæ of an *Agrotis subgothica* which came in at a lighted window, it tumbled about headlong at times, being evidently top-heavy and confused. Another owlet moth, *Drasteria erechtea,* on losing its antennæ did not seem to suffer, and soon recovered sufficiently to fly out of the window upon the grass and to start up in its usual manner and fly off at my approach. A *Crambus* similarly treated acted in a similar manner.

The sense of touch in the Lepidoptera does not evidently reside in the antennæ alone, and all the experiments show that after the loss of the antennæ if disturbed, jarred, or touched, they are still sensitive and fly off.

A few flies were experimented upon, the antennæ being snipped off. A *Chironomus* was much affected; it flew about wildly bouncing on its head, and did not fly up the window-pane upon partial recovery. On the other hand no effect was pro-

duced on a *Tipula* or daddy-long-legs. A large blue-bottle fly (*Musca Cæsar*) seemed to suffer no ill effects, and it was found flying on the window the next day, lively and apparently unconscious of its loss.

Three *Stomoxys calcitrans* on losing their antennæ seemed not at all affected, being as lively as ever, wiping their feet and running and flying up the window, with motions identical with others of their species on the same window.

On removing the antennæ from a beetle (*Harpalus caliginosus*) no difference in its motions was observed; a *Clytus robiniæ* seemed, however, slightly discommoded, while an *Ellychnia corusca*, when mutilated, walked slowly and with difficulty, where before it walked with moderate rapidity touching the ground incessantly with its antennæ; it did not move in a direct line, but hesitatingly, and sometimes tumbling over on one side. It was evidently gravely affected, and finally remained quiet for several hours; a potato beetle (*Leptinotarsa decem-lineata*) acted in the same manner. On the other hand a weevil, *Hylobius pales*, on losing its antennæ, exhibited no signs of discomfort; it did not feign death at first, nor did it walk over the table with a less well directed gait than before.

A few Hemiptera, which, it should be observed, have no palpi, suffered the loss of their antennæ. *Cicada canicularis* flew about more lively than before it was operated upon. In *Coreus tristis* no effect was produced, while a large *Arma*-like bug was made more sluggish.

The red-legged grasshopper (*Caloptenus femur-rubrum*) was not affected, nor was *Orchelimum agile*, while a cricket (*Nemobius vittatus*) on losing its antennæ, at once stopped, not leaping more than two inches, and walked slowly, but used its palpi in walking, cleaning its legs with them. On removing the labial palpi its movements were not different, though, if anything, livelier. On removing the maxillary palpi, no difference in its actions was produced. A common *Gryllus*, in losing its antennæ, was but slightly affected.

A large dragon-fly, *Æschna heros*, on the loss of its antennæ, seemed to fly freely about the room, but would butt against the wall, and on being taken out of doors, flew to the ground, where it usually flies rapidly off in the air.

Spiders seemed to be affected by the loss of their maxillary palpi much as insects by the loss of their antennæ. A female *Lycosa*-like spider, after the removal of its palpi, for four or five

minutes moved slowly, but with a direct, well coördinated gait, then it partly recovered, and moved more briskly. Another smaller *Epeira*-like spider did not seem to suffer, except that its motions were slower, and on being touched, it would gather up its legs and feign death.

A species of *Julus* and of *Polydesmus*, on amputation of their antennæ, rather long stumps remaining, were at first somewhat discommoded and then seemed to walk well, but less rapidly than before.

It would be premature to draw any inferences from these experiments, but the impression is left on the mind that in removing the antennæ in some cases, it seemed as if something more was effected than making the insect deaf or depriving it of the sense of taste or smell, and it seemed as if the ganglionic centres were affected, particularly the supra-œsophageal pair, the insect being at first more or less stunned or confused, and then, in many cases, acting as if the nervous centres were permanently affected; not so much as if one of its senses, but all or nearly all, were more or less affected. In fact, the movements somewhat resembled those of a dove from which the cerebral hemispheres had been removed, as in the case described in Dalton's Physiology, and the fact that the insects can distinguish light from darkness, perhaps the main function of the eyes, and taste their appropriate food, does not militate against the idea that the nervous centres are seriously affected. On the other hand, no such effects are produced when the leg, or even, in some cases, the abdomen, is removed. I do not see that my experiments enable us to prove anything as to the nature of the function of the antennæ, except to indicate that the insect's brain is as it were projected into them, and that their nerves probably possess nucleated cells, homologous with those of the ganglia from which the sense-nerves originate.

RECENT LITERATURE.

Ganin's Metamorphoses of Insects.[1] — The author begins with a rapid survey of previous investigations by Weismann, Uljanin, Chun, Paul Mayer, Auerbach, and shows the unsatisfactory condition of our knowledge and the necessity of a verification of the statements of those

[1] *Materials for a Knowledge of the Post-Embryonal Development of Insects.* By Professor M. Ganin. Warsaw. 1876. 4to, 76 pages and 4 plates. (Extracted from the Transactions of the Fifth Meeting of Russian Naturalists in Warsaw; Section of Zoölogy and Comparative Anatomy.)

authors. "My own observations," says he, "embrace several Diptera (*Anthomyia, Sarcophaga, Musca domestica, Scatophaga, Eristalis, Stratiomyia*); several species of *Formica* and *Myrmica*; one Lepidopteron, *Lithocolletis*; and of Coleoptera, *Tenebrio* and *Chrysomela*. Among the Diptera, my fullest researches were those on *Anthomyia rufipes*, a smaller species being easier to handle in preparing cross-sections, especially in the pupa state, when most of the organs are destroyed. In *Sarcophaga carnaria*, I observed the structure and the development of imaginal discs, anterior to pupation. The relationship of this species, as well as of *Musca vomitoria*, studied by Weismann, to *Anthomyia* authorizes the assumption that whatever is explained here about the development of the latter genus is equally applicable to *Musca vomitoria* and *Sarcophaga carnaria*, and also to the other above-named *Muscidæ*."

"More or less complete are my observations on the development of the teguments of the head, the thorax, and the abdomen, with their excrescences; also on the development of the alimentary canal. The aim of my studies was not so much to investigate the details of the development of this or that organ as to observe the mode of formation of the rudiments of organs, the material out of which they are developed, and the time of their appearance. Many facts, introduced into science by Weismann, — for instance, those which refer to the part played by the imaginal discs in the development of the imago, — must retain their scientific weight, with slight emendations, with respect to the development and structure of those discs; but another category of results, elicited by Weismann, — namely, those relating to the histolytic processes, the formation of the tissues of the imago from the produce of the destruction of the organs of the larva, — must be considered as erroneous and replaced by others." (Pages 4, 5.)

The main portion of the author's dissertation is divided into nine chapters, which embody his own observations, and are entitled, *Imaginal discs* (Muscidæ); *History of the development of the head; History of the development of the abdomen of the imago; Adipose body and destructive processes; Imaginal discs of the ant* (Myrmica); *History of the development of the leg of Lepidoptera and Coleoptera; History of the development of the alimentary canal* (Muscidæ); *History of the development of the proboscis; History of the development of the alimentary canal of Myrmica, Lithocolletis, and Tenebrio.*

It would be impossible fairly to render the contents of these chapters without translating the whole of them; it will suffice here to give a translation of the concluding chapter (page 64), which sums up the author's results and views. "*Conclusions.* In consequence of the above-stated facts, as well as of several still unfinished researches of mine concerning the development of the central nervous system and of the dorsal vessel, we may reach the conclusion that the formation of the organism of the imago, during the period of its post-embryonal development, is

accompanied by the following processes : *Processes of destruction*, when organs or tissues of the larva are entirely or partially disintegrated. The products of this disintegration are not used immediately in the development of new histological elements, but are assimilated by suction and play the part of nutritive materials. *Processes of transformation*, I call those morphological processes, during which the formation of a new organ takes place without the participation of a newly formed morphological rudiment, but when the old organ, without being destroyed, passes into the morphologically corresponding organ of the imago, the newly appearing organ differing more or less, morphologically and histologically, from the old one. Thus the central nervous system of the larvæ of *Muscidæ* is not destroyed, but is transformed into the central nervous system of the imago, the latter differing very much, in its shape and structure, from the former: new parts have appeared; the first knot of the abdominal cord, not existing in the larva, is differentiated; the *ganglion opticum* is newly formed; the shape and structure of the abdominal cord are changed, etc. The histological elements of the tissues of the new organ are derived from those of the transforming larval organ. It is very probable that the dorsal vessel of the imago of *Muscidæ* is only transformed from the dorsal vessel of the larva. It seems to me that in the *Muscidæ* the dorsal vessel does not interrupt its functions during the period of post-embryonal development: very often the contractions of the dorsal vessel of *Anthomyia rufipes* were observed during the second and third day after pupation, when the greater part of the larval organs were already destroyed. The trifling differences between the dorsal vessel of the imago, as compared to that of the larva, may consist in its shape, the number, shape, and position of its wing-shaped muscles, the number and position of the venose openings, etc.

"*Processes of the formation of new organs.* The variety of these processes depends, of course, on the morphological and physiological conditions of the newly forming organ. These processes consist in the building up of an organ of the imago from a special morphological rudiment. Thus from the morphological rudiments called imaginal discs, are evolved entirely new parts of the body of the imago, with their different tissues — head, thorax with the extremities, muscles, nerves, etc.; portions of the cephalic discs are converted into the compound eyes of the imago; out of the thickening of the abdominal segments of the larva of *Anthomyia* is developed the musculature of the abdominal segments of the imago, etc. It must, however, be at the same time remembered that there are no well-marked boundaries between these different processes; the terms used are intended merely to designate the most marked phase of this or that process. The definitions given of those processes have only a relative meaning, like all our definitions in morphological science.

"Finally, it also happens that parts or organs of the larva, during the period of the post-embryonal development, will pass into the corresponding parts of the imago without any change, or with very little change. Thus, for instance, a part of the adipose body of the larvæ of the *Muscidæ* and of the ant pass into the adipose cells of the imago. It is worthy of notice that it is only after the last molt of the larva of *Corethra* that those large bundles of colossal adipose cells make their appearance, which surround the anterior tracheal bladders; but they pass without any change into the imago, without furnishing, directly or indirectly, any material for the formation of the organs of the imago. This fact, taken singly, does not weigh in favor of the importance of the adipose body as a living, plastic material for building up the organs of the imago in the period of the post-embryonal development. The so-called histolytic processes, in the sense of Weismann,[1] as well as the process of an independent formation of the cells from the products of the destruction of the larval organs, I have never observed.

"The comparative examination of all these processes, which take place in the period of the post-embryonal development of different insects, leads us to the conclusion that, from the number of the processes of new formation and destruction, as well as from their morphological meaning, the highest place in the series of all the insects must be granted to the *Muscidæ*. Besides the already known facts of comparative anatomy, may be adduced the data obtained through embryological researches, which confirm the above-mentioned statement. The position of the imaginal discs in the cavity of the body, the mode of development of the head, the chest, the proboscis with all its parts, the entire destruction of the exoderm of the first four segments of the larva, the entire destruction of all its abdominal muscles, etc., — all these circumstances lead to the conclusion that the organism of the *Muscidæ* has undergone more modification than that of any other insect, during its phylogenetic development. The mode of development of the strata of rudiments in the imaginal discs of the *Muscidæ*, as compared to that in the discs of other insects, serves to confirm that conclusion. In the larvæ of *Muscidæ*, both strata of rudiments of the disc are formed anew from a common cellulose germ on the peritoneal envelope of the tracheal tube, or on the neurilemma of the nerve. In *Corethra*, *Miastor*, and in the Hymenoptera, strictly speaking, the mesoderm of the disc is alone a new formation, developed with the participation of the nerve and the tracheal tube; the exoderm of the disc is derived from the epithelial

[1] I say in the sense of Weismann because later observers, as C. Chun, P. Mayer, often use the term *histolyse* indifferently: often cases of ordinary destructive processes are called by them *histolyse*. Weismann, on the contrary, clearly distinguishes this second *histolytic* process from the three other processes of formation of the organs of the imago. The *histolyse*, according to Weismann, takes place only when the organ of the larva furnishes the skeleton to the organ of the imago, etc., etc.

cells of the thoracic segments of the larva. In butterflies and beetles, the part corresponding to the exoderm of the imaginal disc is derived from the epithelial sac of the leg of the larva; the mesoderm likewise is a new formation. It is very probable that a further inquiry into the processes of the post-embryonal development of other Diptera, and also of insects of other orders, principally of such groups as have so-called apodal larvæ, will disclose some transitional forms of post-embryonal processes leading towards the extreme and well-characterized type of development of the *Muscidæ*. Thus it is now well known that *Miastor*[1] is a connecting link between *Muscidæ* and *Tipulidæ*, as regards the history of the development of its head. The dorsal portion of the head of *Miastor* is developed from the cephalic discs, the position of which is similar to that of the cephalic discs of the *Muscidæ;* the ventral and lateral portions of the head of the imago of *Miastor* are developed with the participation of the teguments of the larval cephalic segment. The development of the organs of the mouth of *Miastor* is much nearer to that of *Corethra.*

"The musculature of the head of the larva of *Miastor*, according to Zalensky, passes without change into the muscles of the head of the imago. It is to be regretted that we do not find in the work of Zalensky any mention of destructive processes in the cephalic segment of the larva of *Miastor*. If the destruction of the exoderm of the cephalic segment of the larva is not recognized, at least in its dorsal region, it is difficult to understand how the newly formed part of the head can assume its normal relative position towards the old larval exoderm of the cephalic segment.

"Some morphological importance must also be attributed to the interesting fact, that in the larva of *Miastor*, the formation which is homologous to the pair of cephalic discs of the larvæ of *Muscidæ* appears in the shape of a single (not paired) organ, although judging by the nerves with which it is connected, it corresponds to the pair of cephalic discs of the *Muscidæ*.

"The principle adopted by Weismann for the division of all insects into two sharply defined types, according to their post-embryonal development, and which depends upon the presence or absence of histolytic processes, and also on the mode of formation of the histological elements of the tissues of the imago, — in one case from the *Körnchenkugeln*, in the other with the participation of the elements of the tissues of the larva, — after all that has been said above, must lose its scientific value. It seems to me that the principles which must guide us in the grouping of insects with regard to their post-embryonal development are the number and quality of the destructive processes, the different modes of the building up of the organs of the imago from the newly

[1] Article by Mr. Zalensky, in the Proceedings of the Third Meeting of the Russian Naturalists in Kiew.

formed morphological rudiments, the number and the morphological importance of the organs transformed from the organs of the larva, and of those which pass, without change, into the organs of the imago.

"I deem it proper to examine here the question of the morphological importance of the imaginal discs of insects in general. The data respecting their embryology and comparative anatomy render it very probable that the thoracic imaginal discs, hidden in the body of *Muscidæ*, the thoracic imaginal discs placed immediately on the skin of *Corethra*, *Miastor*, and the Hymenoptera, and the thoracic legs of the larvæ of Lepidoptera and Coleoptera, are homological formations, replacing each other in all those groups. In other words, and more explicitly, I believe that the thoracic imaginal discs of the Hymenoptera, *Muscidæ*, *Corethra*, and *Miastor* are nothing but reduced ambulatory legs, which in other insects (Lepidoptera and beetles) are used as organs of progression, but in the above-mentioned groups (*Muscidæ*, etc.), have lost their physiological value, and have preserved in the history of their development a mere record of that value. This view may be sustained by the following scientifically pregnant facts: (1.) All insects, the larvæ of which possess, in their thoracic segments, the so-called imaginal discs, do not have any rudiments of legs on the same segments during the period of their embryonal development; in other words, the imaginal discs take the place of the legs, which, in other insects, appear much earlier, in the same places, during the period of the embryonal development. (2.) In insects, the larvæ of which possess thoracic legs, these latter are transformed into the legs of the imago, in such a manner that the final segmentation of the joints of the leg of the imago appears more or less sudden and simultaneous, in consequence of the segmentation of the corresponding leg of the larva, which has been very much drawn out in length. On the contrary, those insects, the larvæ of which, instead of thoracic, ambulatory legs, have imaginal discs, show, before the appearance of the final segmentation of the leg of the imago, a stage of a *provisional* segmentation of the leg in the developing imago. Thus, the segments of the leg of the imago of *Muscidæ*, Hymenoptera, etc., do not all appear simultaneously, but gradually, first one, then two, three, etc. This provisional segmentation of the leg, growing out of the imaginal disc, must be considered, probably, as the expression of the ultimate segmentation of the leg which it formerly possessed; or, in other words, the provisional segments of the leg, developing from the imaginal disc, remind us of the permanent segments of the larval legs of Lepidoptera, beetles, etc., which, in these latter, are used as temporary, provisional, locomotive organs. (3.) I believe that great morphological importance must be attached to the fact that during the development of the imaginal disc of the *Muscidæ*, the Hymenoptera, *Corethra*, and *Miastor*, the provisional cavity in the disc, which has no ultimate meaning, appears first of all. The scientific meaning of this provisional cavity, as well as of its out-

ward tegument, can be explained, I think, as follows: The fact that imaginal discs, formations homologous to ambulatory legs, are situated in the cavity of the larval body, in connection with the tracheæ and nerves, must undoubtedly be understood as a consequence of the compound process of the displacement of the imaginal disc from the surface towards the inner cavity along the tracheal tube or nerve. The larvæ of *Corethra*, *Miastor*, *Chironomus*, have the imaginal discs more on the surface of the skin than those of the ant (*Myrmica*). In the former larvæ, these formations are walled in by a comparatively less developed fold of the skin. In the larvæ of *Myrmica*, this deep fold is transformed into a well-developed bag, which, together with the leg of the imago, developing within it, is placed during a certain time within the cavity of the larval body, below its muscular, subcutaneous stratum. In these insects, after the leg is stretched outside, the bag enclosing it is atrophied, and has no ulterior meaning. If we represent to ourselves that the outside aperture, leading into the provisional bag, with the incipient leg of the ant, is closed, we obtain all the homological parts of the disc of an ant as compared to the disc of *Muscidæ* in the corresponding stage of development. That is, the part of the disc of the *Muscidæ* which I described as its outside tegument, becomes the homologue of the closed fold of the skin in the disc of the ant; the provisional cavity of the disc of *Muscidæ*, between its outer and inner tegument, is homologous to the cavity of the bag in the disc of the ant; the inner tegument of the disc of the *Muscidæ* and the thickening of the anterior half of the disc of the ant represent the beginnings of the leg of the imago, and are homologous formations. The phase of development of the imaginal disc of the ant, before it begins to project externally, when the extremity consists only of three provisional segments, and the corresponding phase in the disc of *Muscidæ*, entirely concealed within the cavity of the body, are remarkably alike anatomically, if we do not pay attention to the external opening in the disc of the ant. It seems very probable that, when the post-embryonal development of different insects is better investigated, embryological facts will be found, which will favor the view, explained above, of the imaginal disc of *Muscidæ* being comparable to the disc of the ant (*Myrmica*). I mean to say, that an intermediate stage of the imaginal disc will be found, during which it occupies in the full-grown larva a position similar to its position in the larvæ of *Muscidæ*, and has at the same time its outer integument and provisional cavity similar to those of the ant.

"The paired abdominal thickenings which appear on the sides of the abdominal segments in the larvæ of *Muscidæ* before the formation of the permanent abdominal segments of the imago are, I think, morphologically homologous with the thoracic imaginal discs, and may be called abdominal imaginal discs.

"The facts communicated by me concerning the formation of the ali-

mentary canal of the imago during the post-embryonal development induce us, first of all, to reflect on the question, What transformation does the entoderm of insects which undergo the so-called complete metamorphosis pass through from the very beginning of the life of such insects? For the solution of the question how many times the entoderm of such insects is changed, science unfortunately does not as yet possess sufficient data concerning the development of the entoderm during their embryonal development.

"If the supposition of some investigators, who look upon the abdominal depression very early visible in the blastoderm of *Hydrophilus*, *Apis*, etc., as a stomach (*gastrula*), proves to be correct, and if, secondly, my observations are verified, that, notwithstanding the presence of this provisional entoderm (*gastrula*), the final epithelium of the median intestine of the embryo may develop anew with the help of the epithelium of the anterior and posterior intestine, then we will be able to affirm with assurance that the imago of insects with a complete metamorphosis has a *tertiary* entoderm. On the contrary, if it become established as a scientific fact, that the stomach (*gastrula*) of insects is transformed directly into the entoderm of the median intestine of the larval embryo, then the entoderm of the imago of the above-indicated insects should be called *secondary*. There is a considerable array of facts in favor of both of these suppositions, but in order to obtain a final solution of this important morphological question, we must wait for more numerous observations on the development of the entoderm during the embryonal and post-embryonal periods.[1]

"As to the anterior and posterior intestine, it seems very probable that these portions of the alimentary canal of the imago of insects which have a complete metamorphosis are *secondary* formations."

Recent Books and Pamphlets. — On the Fishes of Northern Indiana. By D. S. Jordan. On the Genera of North American Fresh-Water Fishes. By David S. Jordan and Charles S. Gilbert. (From Proceedings of the Academy of Natural Sciences, Philadelphia.) 8vo, pp. 104.

Die Wanderheuschercke (Œdipoda migratoria Linn). Gemeinverständliche Darstellung ihrer Naturgeschichte, Lebensweise, Schädlichkeit, und der Mittel zu ihrer Vertilgung. Von Dr. A. Gerstäcker. Berlin. 1876. 8vo, pp. 67. Two colored plates.

Catalogue of the Lepidoptera of America North of Mexico. Part I. Diurnals. By William H. Edwards. Philadelphia, Pa. 1877. 8vo, pp. 68.

Antigeny, or Sexual Dimorphism in Butterflies. (From the Proceedings of the American Academy of Arts and Sciences, xii. 1877.) 8vo, pp. 8.

Bulletin of the United States Entomological Commission. No. 2. On the Natural History of the Rocky Mountain Locust, and on the Habits of the Young or Un-

[1] Paul Mayer, in his Ontogeny and Phylogeny of Insects, speaks of the gastrula-stomach of the embryo of *Platygaster*, without noticing that this stomach is simply a fold of the body of the embryo, separating its cephalic and caudal haloes. The embryo of *Platygaster* is a highly convenient object for observation, and I can say with assurance that in this case the primary entoderm is not formed through the invagination of the exoderm.

fledged Insects as they occur in the More Fertile Country in which they will hatch the Present Year. Washington, May, 1877. 8vo, pp. 15.

The Westminster Review on The Recent Origin of Man. By James C. Southall. (Extracted from the Methodist Quarterly Review for April, 1877.) 8vo, pp. 25.

Gar-Pikes, Old and Young. By Prof. B. G. Wilder. (Reprinted from the Popular Science Monthly, May and June, 1877.) 8vo, pp. 22.

The Growth of Children. By H. P. Bowditch, M. D. (From the Eighth Annual Report of the State Board of Health of Massachusetts. Boston. 1877. 8vo, pp. 51.

Annual Report of the Trustees of the Museum of Comparative Zoölogy for 1876. Boston. 1877. 8vo, pp. 47.

GENERAL NOTES.

BOTANY.[1]

ORCHIS ROTUNDIFOLIA Pursh. — This, after all, is the proper name for this rare species, which is likely to be more common, now that Mr. Pringle has found new stations in Vermont, where it abounds. From live plants sent by Mr. Pringle to our Botanic Garden, the plant is now in blossom, and an examination of the fresh flowers reveals the fact that the plant is a genuine *Orchis*, having the glands in a pouch. In fact, it is a true congener of *O. spectabilis*, but with lateral petals spreading in the manner of most European species. It was Richardson who first referred this *Orchis* to *Habenaria*, and as he was aided by Robert Brown in the preparation of his Botanical Appendix to Franklin's Journey, one felt confident that all was right. Let our young botanists note from this how much is to be done, if they will but use their eyes. — A. GRAY.

THREE-FLOWERED SANGUINARIA. — From Galva, Illinois, H. W. Young sends a scape of *Sanguinaria Canadensis* which, besides the terminal flower, bears a pair of similar lateral flowers, one on each side, at some distance below, apparently without subtending bracts; an interesting and novel monstrosity. — A. GRAY.

TWO-FLOWERED ARETHUSA. — I found near here two days ago a remarkable specimen of *Arethusa bulbosa*, L. It was in a place where this species is not uncommon, but I have never seen so fine a specimen. There were two distinct scapes from the same bulb, one bearing a single flower, and the other a pair of flowers, all perfect and unusually fine ones. The scapes were not longer than is usual, but quite stout and healthy. — H. M. DENSLOW, New Haven, June 1, 1877.

In a package of several hundred fine specimens of *Arethusa*, just received from Plymouth, Mr. B. M. Watson has observed two interesting monstrosities. One of the specimens consists of a two-flowered scape, with the flowers complete and united at the base; the other has the flowers, which are both incomplete, united through nearly the whole length.

[1] Conducted by PROF. G. L. GOODALE.

DOUBLE SAXIFRAGE, AGAIN. — At a recent meeting of the Academy of Natural Sciences of Philadelphia, Mr. Meehan exhibited a specimen of *Saxifraga Virginiensis* having double flowers. Subsequently Dr. J. G. Hunt exhibited a specimen of like character; both were collected on the banks of the Schuylkill River near Philadelphia. The flowers on each specimen were few in number, but of larger size than those noted by Professor Gray in the June number of the NATURALIST. — ISAAC C. MARTINDALE, Camden, N. J.

SALIX CANDIDA IN ESSEX COUNTY. — I found this plant by accident in a swamp in Boxford, while on one of the local exploring trips last summer in company with J. H. Sears, who is familiar with that region. I had then the leaves only. This month we went again to the place and found male and female plants abundant in the vicinity of the *Pinus resinosa* grove. *Salix myrtilloides* grows there also, but this has been found also in North Reading, Andover, Danvers, and Hamilton. Oakes had *S. myrtilloides* from "Topsfield" in 1846.

I also send two varieties of *Draba Caroliniana*, discovered on Salem Neck by Dr. Charles Pickering in 1824. It grows abundantly some years, and is scarce others. There is an acre or two of it. One form is very white beneath the leaves, later flowered and lighter, and having thicker pods than the other, which is darker, with thin pods. Mr. Russell knew the place, and I have watched it every year since 1870. — JOHN ROBINSON, Salem.

SARRACENIA VARIOLARIS. — In 1874 I prepared notes on *S. variolaris*, in which it was stated, as one of the conclusions reached, that the sweet secretion at the mouth of the tubes was simply a *lure* to insects and *not* stupefying or intoxicating as had been supposed. Last year, having read an interesting article on this subject, in which the writer arrived at conclusions directly opposed to my own, I was curious to discover whether I had committed any error, but it was too late at that season to repeat former experiments.

On the 15th of this month, therefore, I procured about midday from a neighboring pine barren a number of leaves of this plant which were brilliantly colored and secreting freely. While still fresh, the upper portions of these leaves were cut off and slit open, thereby exposing the honeyed secretion on the internal surface, which was very abundant and glistening, sweet to the taste and viscid to the touch. These were then flattened out on a large newspaper, the whole surface of which was covered with them. Many house flies were soon attracted and commenced to feed, and I carefully watched their motions without any interruption for the space of one hour. The result was precisely as previously stated. In no instance did I discover the slightest unsteadiness or tottering in any of the flies, although I watched some of them feeding at one spot for at least ten minutes, at the expiration of which time they flew off apparently unhurt. They continued feeding and flying off from the

leaves during the hour I watched them, and certainly not one fell, nor was there any indication at any time of either stupor or intoxication.

These experiments I repeated in the same way on the 25th (but later in the day) and as carefully as on the previous occasion, and with precisely the same results; also on the next morning (26th) with plants which had been collected the day before, and these seemed to secrete still more freely. I ask, therefore, if flies and other insects are indeed intoxicated from eating the honey when they are *within* the tube, why should not the same intoxication result when the tubes are opened and flattened out? I conclude then (as I did before) that it is only the peculiar conformation of the leaf in its overhanging hood and internal slippery surface which entraps and finally destroys insects, and that the sweet exudation is only a *lure*, and *not* intoxicating in any way! I may remark that after flies and other insects slip and stumble, *if* they were indeed intoxicated or stupefied, it seems likely that they would remain at the lower portion of the leaf, and that their motions would be feeble and sluggish. On the contrary their efforts for escape are most active and vigorous, the flies flying and buzzing continually, and other insects incessantly climbing and falling back! It is only after being exhausted by their efforts that they eventually get slimed by the liquid at the base of the leaf, and stupor then overtakes them.

I have seen ants, and occasionally flies also, fall immediately as they entered the leaves before they could have eaten honey.

I remark further, that if this sweet internal secretion be stupefying, that outside on the wing (the "trail") must be equally so, and therefore insects ought to be found at the base of the leaves *on the ground!* I have never myself seen such, nor have I ever heard of any other persons observing dead or intoxicated insects *outside!* — J. H. MELLICHAMP, Bluffton, N. C.

Dr. Mellichamp sent, shortly after this communication, two phials of the fluid found at the bottom of the Sarracenia tubes. The bottle marked number one contained fluid collected in 1874; it was clear and without much sediment. It was neutral in reaction. The fluid in the other bottle (number two) was collected partly from the still unopened leaves, at a time when "no rain had fallen for near two weeks." This fluid was turbid, had very little if any taste, and was slightly acid in reaction. Experiments by Mr. B. M. Watson and Mr. Hancox in our Botanical Laboratory confirmed, in the main, the following interesting statement by Dr. Mellichamp: "Pour out a teaspoonful or two of the fluid in an ounce measure, or a small wine-glass. Throw in a fly so that his wings will be wet or slimed. He will in a few minutes cease to struggle and will appear as if dead. Take him out after a while and let him dry, and in about half an hour he will revive." Number one proved to be nearly or quite inert. Number two was very active. The detailed results of Mr. Watson's experiments, which are still in progress, may be published in the August NATURALIST.

Botanical Papers in Recent Periodicals. — *Flora*, No. 10. Batalin, Mechanism of the Movements of Insect-Eating Plants. H. G. Holle, On the Activity of Assimilation in *Strelitzia reginæ* (continued in Nos. 11 and 18). No. 11. F. V. Thümen, Notes on "Mycotheca Universalis." H. Leitgeb, On Bilaterality of Prothallia. No. 12. Dr. George Winter, Lichenological Notices.

Botanische Zeitung, Nos. 17, 18, and 19. H. Hoffmann, Experiments on the Culture of Variable Forms of *Achillea Clavennæ*, *Aquilegia vulgaris*, *Avena orientalis*, *Hordeum trifurcatum*, *Papaver Rhœas*, *Plantago alpina*, and *P. maritima*, *Polygonum amphibium*, *Rumex scutatus*, *Silene rupestris*, *Triticum turgidum*. Dr. J. Peyritsch, With Reference to the Ovular Theory. No. 20. Dr. H. Banke, The Development of the *Ascomycetes*.

ZOÖLOGY.[1]

The Mountain Boomer, or Showtl. — This name is applied in Oregon to the *Aplodontia leporina*, or "Sewellel," a rare rodent of the Pacific coast. According to Dr. F. S. Matteson, of Coquille, Coos County, Oregon, "the animal in question is found living in communities, and burrowing into the dry hills and mountain spurs in the 'burns' of this region. It is called 'mountain boomer,' and makes a kind of booming noise. It is also called 'mountain beaver,' as in its appearance and burrowing habits it remotely resembles the beaver. It is a vegetarian, subsisting most probably on barks and roots, and is a rarity even here, being exceedingly shy and difficult to catch." We add the following account by Dr. Matteson in his own words: —

The showtl inhabits the western slope of the "Coast Range" of mountains, from Puget Sound to California. He is a digger *par excellence* and burrows into the sides of the hills, usually in the neighorhood of a spring. He is patriarchally social, and settles his progeny around him, often forming quite a community. He is of a retiring disposition, choosing the deep recesses of the mountains for his home, and appears to understand intuitively that the white man is to him an undesirable neighbor. He is herbivorous, and is supposed to subsist upon the roots and succulent stems of annual plants, chief among which is the mountain fern, which usually grows luxuriantly near the spot which he selects for his burrow. When the rainy season, which is our winter here, comes, he retires to his under-ground domicil, first covering the entrance with the leaves and stalks of the fern, and proceeds to enjoy himself in the bosom of his family until the return of spring. Whether he really hibernates or not is a disputed point with the showtl sharps of this region, but the weight of authority appears to favor the views of the hibernationists. I know that I have never been able to procure any specimens in winter, and those of early spring are remarkable for seediness, as though a

[1] The departments of Ornithology and Mammalogy are conducted by Dr. Elliott Coues, U. S. A.

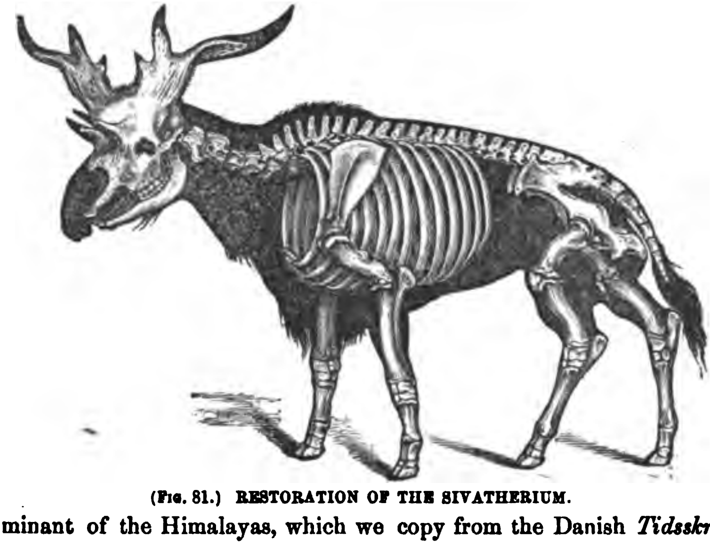
square meal were among the dim recollections of his past. On the contrary those caught in the autumn are fat, sleek, jolly-looking fellows, like the rest of the inhabitants of this valley.

This animal is called by the people here "marmot," and "mountain beaver," from his slight resemblance to the beaver; but he is more generally known as mountain boomer, from his habit, as it is said, of making a kind of booming noise. And this is all the information I have in regard to his cry or voice.

I am told that his flesh is excellent food, and that the Indians eat him freely, but it has never been my fortune to come into possession of a sample on which I cared to experiment in that direction.

He is seldom seen abroad, being very shy, and is trapped by setting a small steel-trap in the mouth of his hole. But he is exceedingly wary about "putting his foot in it," and, having several entrances to his subterranean dwelling, prefers to go and come by another door, and thus cheat the greedy trapper of his intended victim. He is accredited with being a fightist when captured and goes for his captor savagely, but when caught in a trap, even by a foot only, is usually found dead when the trap is visited. He appears to have no object in life except to dig holes, and eat fern roots. He does no harm, or good either, to the settler or anything else, for that matter. He is neither useful nor ornamental, and the sole purpose of his creation appears to be to furnish a rare and queer animal for curious naturalists to place in their collections. — F. S. MATTESON, M. D., Coquille, Coos Co., Oreg., November 29, 1876.

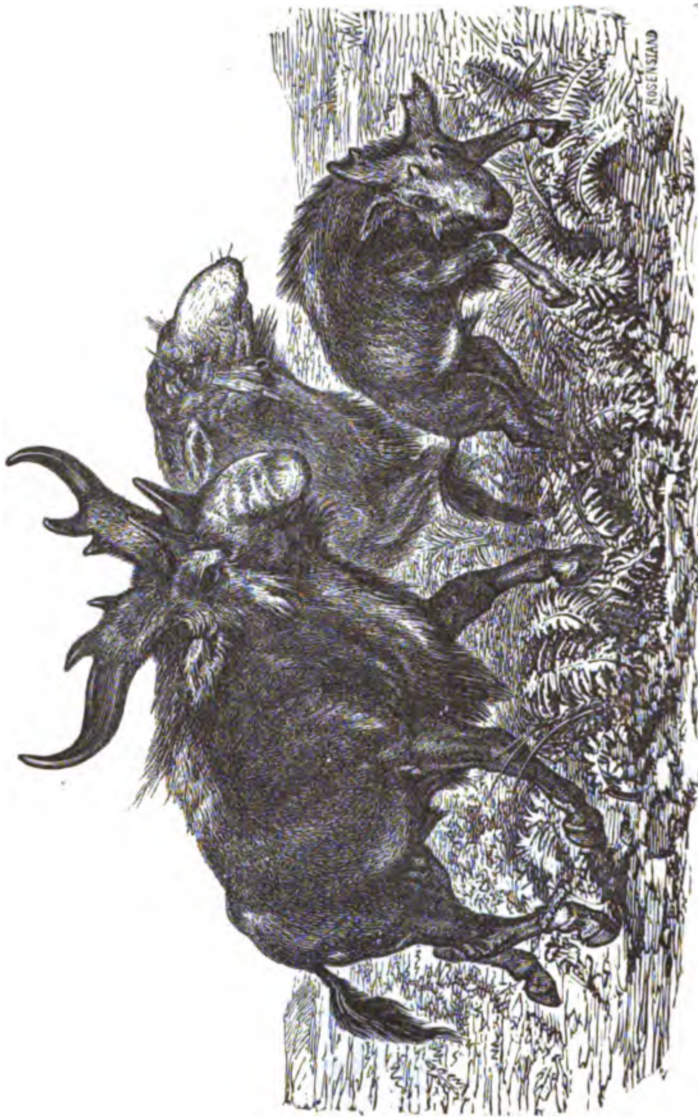
RESTORATION OF THE SIVATHERIUM. — Most of our readers have probably never met with the accompanying figures restoring the gigantic



(FIG. 81.) RESTORATION OF THE SIVATHERIUM.

ruminant of the Himalayas, which we copy from the Danish *Tidsskrift*. This was a Tertiary, probably Miocene, "elephantine stag, having four horns and probably a long proboscis, being in some points between the

stags and the Pachyderms. It is supposed to have had the bulk of an elephant and greater height." (Dana's Manual.)



(Fig. 82.) Restoration of the Sivatherium.

ANTHROPOLOGY.

Anthropological News. — The *Journal* of the Anthropological Institute, for January, is very largely devoted to Polynesian subjects. The following papers are published in full: Notes on a Collection of Skulls from Mallicollo and Vanikoro, by Geo. Busk. Notes on the Nicobar Islands, by W. L. Distant; Signor S. M. D'Alberti's Expedi-

tion to New Guinea, by A. W. Franks; On the South Sea Islanders, by W. L. Rankin. Several papers are devoted to British archæology. M. Van der Horck contributes a paper on the Laplanders, and the Rev. W. Harper treats of The Tribes of British Guiana.

An elaborate, illustrated work on the archæology of Finland has lately been published in Helsingissä, by Johann Reinhold Aspelin. The title is Suomalais Ugrilaisen Muinaistutkinnon Alkeita.

Matériaux for January contains the usual amount of information concerning local explorations. In addition to this is a review by Montelius of the history and antiquities of Sweden, and of Pinart's Tumuli in Vancouver's Island.

Nature of February 15th contains a letter from Mr. Gerald S. Davies on the Obsidian Cutters of Melos. This is an interesting account of a series of obsidian cores and flakes from the Island of Melos, some having a "singular wavy pattern on the back ridge."

The French Anthropological Society has been authorized to open an international exhibition in the central palace of the Trocadero. M. Quatrefages has been appointed chairman of the commission.

We take great pleasure in welcoming to our fraternity of ethnological laborers Mr. Albert S. Gatschet, of Weimar. The following of his papers have come under our notice: Twelve Idioms spoken in the Southwest of North America, Weimar, 1876, 8vo, pp. 150; Indian Languages of the Pacific States and Territories, in the *Magazine of American History*, March, 1877; and Analytical Report of Eleven Idioms spoken in Southern California, Nevada, and on the Lower Colorado River, their Phonetic Elements, Grammatical Structure, and Mutual Affinities, in Lieut. Geo. M. Wheeler's Annual Report, 1876. In the same report will be found the following anthropological papers in addition to the one mentioned above: Report on the Operations of a Special Party for making Ethnological Researches in the Vicinity of Santa Barbara, Cal., with an Historical Account of the Region explored, by H. C. Yarrow, M. D.; Notes upon the Ethnology of Southern California and the Adjacent Regions, by Dr. O. Loew; and On the Physiological Effects of a very Hot Climate, by the same author. The amount of human remains, mortars, ollas, etc., found at one locality, described in Dr. Yarrow's paper, was so immense that they named it the Big Bonanza.

The American Geographical Society has recently published Major J. W. Powell's paper, entitled Outlines of the Philosophy of the North American Indians. The major divides the subject as follows: Introduction: Savagery as Ethnic Childhood; Cosmology: System of Worlds, Heavenly Bodies, Meteorological Phenomena, Geographical Phenomena-Remarkable Facts in Nature, Important Facts in Human Society; Theology: Beast Gods, Hero Gods, Daimon Gods, Firmament Gods, Tutelar Gods; Religion: Priestcraft, Prophets, Shamans, Witches, Ecstacism, Amuletism; Mythology.

In the *Western Review of Science and Industry* for February are the two following articles: The Missouri Mound Builders, by Judge E. P. West; and The Functions of the Uvula and the Prominence formed by the Azygos Uvulæ Muscles, by Thos. F. Rumbold, M. D. The last named is reproduced from the *St. Louis Medical and Surgical Journal.*

Mr. A. R. Grote contributes to the *Popular Science Monthly* a paper on The Early Man of North America.

In *Nature*, February 8th, Mr. A. W. Howitt, of Bairnsdale, Gippsland Victoria, adds something to his former notes on the boomerang. We are informed by Mr. Holmes, of Hayden's Survey, that the Moquis use their boomerangs for killing rabbits. A party of young men are detailed each morning to go hunting. Each one carries a bunch of these weapons slung over his shoulder. They shy them with great force and precision, but, of course, have no idea of their returning. Here, then, is the primitive boomerang, one step lower than the Australian, excelling the ordinary club by its more rapid flight, and by its following more strictly a plane of revolution.

In *Academy*, for February 24th, and March 3d, 10th, and 17th, will be found letters from Messrs. Sweet, Ellis, and Phillimore upon Spelling Reform. This subject becomes a very important one to the ethnologist at this time, when great interest is manifest in the collection of Indian vocabularies. It is a conceded fact, we believe, that, until the American Philological Association produces its phonetic alphabet, we must endeavor to record our vocabularies in such form that they can be reproduced at any printing-office.

Frequent references are made in European journals to the fact that many chipped arrowheads have a spiral form, as if to give a rotary motion to the arrow in its flight. In a conversation with Mr. Frank Cushing, the assistant of Dr. Rau, at the National Museum, who is also an expert at making flaked and chipped implements from bottle glass, etc., I asked him why he so often gave his points a spiral twist. He replied, "Because I cannot help it. When I hold the butt end of the arrowhead against the ball of my thumb, I have a good bearing, and can take off long flakes; but when I reverse the object to chip the other side, I have a poor bearing, and can take off only small chips. The same is true of the opposite edge, only the long chips will come from alternate sides, giving the point the appearance of a twist." Mr. Cushing has made thousands of chipped implements, and agreed with me that the twist or spiral was a necessity over which the savage had no intelligent control. Subsequently this undesigned improvement may have led to the alternate chisel-edge of some of Dr. Rau's specimens at the Centennial Exhibition.

The anthropological map accompanying Reclus' Nouvelle Géographie Universelle was prepared by M. G. de Mortillet. The palæolithic localities of France marked amount to 396. The neolithic localities comprise 26 natural caves, 144 artificial caverns, and 2314 dolmens.

GEOLOGY AND PALÆONTOLOGY.

NATURE OF THE LEGS OF TRILOBITES. — Mr. C. D. Walcott has published a second paper in the Report of the New York State Museum, entitled Preliminary Notice of the Discovery of the Remains of the Natatory and Branchial Appendages of Trilobites. Over two hundred trilobites have furnished evidence of appendages, and all were found resting on their backs, so that Mr. Walcott concludes that they must have swum on their backs. (It may be noticed here that the larval *Limulus* nearly always swims on its back, as does the Phyllopod *Apus*.) He states that "they had a double row of appendages on each side of the central axis. The central or axial series were either the attachments of swimming lobes or rudimentary ambulatory legs. The lateral series were branchial in their structure, the bars serving as points of attachment for their lamellæ. It is probable that they were also used in swimming. Many sections show appendages beneath the head, but nothing satisfactory can be shown from them." He adds: "Additional evidence, obtained from sections of *Calamene senaria*, proves that the central or axial appendages were articulated to the thickened arches of the ventral membrane, on a line with the outer edges of the alimentary canal. The structure of the appendages, as shown in numerous microscopic, transparent, and opaque sections, leads me to the conclusion that they were the support of swimming lobes. What may have been a portion of the swimming lobe has been seen in several sections near the end of the appendage." These appendages terminate either in a round, blunt point, or else appear as if crushed. The form and outline of the swimming lobe could not well be preserved. Transverse sections display the ventral membrane between the axial appendages, the space occupied by the alimentary canal, and the axial and branchial appendages. The axial are but one third the length of the latter. The perfect state of preservation of the delicate branchial appendages and the ventral membrane precludes the idea of the destruction of anything of a stronger texture than fleshy swimming lobes attached to the axial appendages. The axial appendages could not have reached to the surface upon which the edges of the pleuræ rested, which negatives the view of their being in any way ambulatory in case the non-presence of articulations in the appendages should be called in question. The axial appendages of each series approximate each other near the posterior end of the hyportoma. What may be called oral appendages extend out between the hyportoma and the dorsal shell, or else they were articulated to a membrane connecting the hyportoma and dorsal shell of the head.

GEOGRAPHY AND EXPLORATION.

THE GEOGRAPHICAL WORK OF THE UNITED STATES GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES. — Mr. A. D. Wilson, chief topographer of Hayden's Survey, gives in the Bulletin of the

Survey an interesting sketch of the mode of carrying on the geographical work of the Survey, showing the evidence on which the final maps prepared by the Survey rest. The primary triangulation was in charge of Mr. James T. Gardner until the autumn of 1875, when, on his resignation, the work was continued by Mr. Wilson. To give some idea of the amount of work that has been done by the topographical corps in the Survey of Colorado, it may be stated that it has established 1280 topographical stations within an area of about seventy thousand square miles, and from each station all the surrounding country was sketched. Mr. Wilson's assistant made over one thousand pages of profile sketches during the field season of 1875, each page being six by ten inches, while he himself made some five hundred pages of drainage sketches, and took the thousands of angles that were necessary to locate all the points. The high order of the work done, added to the difficulties and dangers under which geographical labor is performed in the most mountainous and wild section of our country, reflects credit upon our government in authorizing and sustaining such undertakings.

Geographical News. — *The Geographical Magazine* is publishing an account of the Official European Cartography in 1875–76, which possesses a good deal of interest. Among recent books of travel are Cameron's Journey across Africa; Canoe and Camp life in British Guiana, by C. Barrington Brown; The Cradle of the Blue Nile, by E. A. De Cosson; Peru in the Guano Age, by A. J. Duffield. Baron von Richthofen's new work on China is ready for publication. An eruption of Mauna Loa, the great volcano of Hawaii, took place on February 14th, in a new district. The lava probably came from the summit-rent, and traveled to the coast by subterranean passages.

MICROSCOPY.[1]

Zentmayer's Turn-Table. — Mr. Zentmayer has recently contrived a turn-table on which the slide is self-centred for width, by the absurdly simple device of bringing its two sides up to the opposite sides of a couple of brass pins equally distant from the centre of rotation. The adjustment for length is made by hand, guided by circles on the brass plate, or for slides of standard size by a pin at one end. The slide may be of any reasonable width, and can be easily and instantly decentred for refinishing old slides. The table is mounted with a clamp for attaching it to a table, though it can be furnished on a heavy block in the usual manner, if desired.

Microscopy at Nashville. — At the Nashville meeting of the American Association for the Advancement of Science, commencing August 29th, and continuing about one week, special arrangements will be made for the care of instruments and for the convenience of those who wish to use them. The local sub-committee having charge of these arrangements consists of Dr. T. O. Summers, Jr., and Profs. G. S. Blackie

[1] Conducted by Dr. R. H. Ward, Troy, N. Y.

and Alex. Winchell, who will leave nothing undone that is believed to be for the advantage of this department. As microscopy has been made a permanent sub-section, it is now, in reality, a national society of microscopists, with power to elect officers and continue its organization from year to year, and to avail itself of the great facilities and advantages of meeting with, and as members of the American Association. It was the unanimous and earnest desire of the members present at the last meeting, at Buffalo, that all the microscopists of the country, and especially the officers and members of microscopical societies, should take a hearty interest in the enterprise, and contribute to its usefulness by attending the meetings when possible, and sending contributions to be read if unable to attend personally. Circulars giving particulars of the arrangements for this meeting can be obtained from Dr. T. O. Summers, Jr., of Nashville, chairman of the local sub-committee, or from the editor of the microscopical department of the NATURALIST.

SHELL-SAND FROM THE BERMUDAS. — C. C. Merriman, of Rochester, N. Y., whose name we have had occasion to mention before in these pages, has just returned from a few months' visit at the Bermuda Islands, where he has gathered some quite remarkable specimens of shell-sand, composed almost entirely of foraminifera. It is interesting not only as a beautiful object under the microscope, but as being the material of which the islands are formed. In favorable conditions of winds and tides it may be gathered on the sand beaches quite fresh from the ocean, in which case the shells and corallines and sponge spicules are in great part unbroken, and many of them beautifully colored. Such conditions, however, occur quite rarely, as Mr. Merriman was able on two days, only, of his visit to make perfectly satisfactory collections. He has contributed a set of six exceedingly interesting and beautiful slides to the "Postal Club." Slides or material for the same can be obtained from him in exchange for any really interesting or valuable slides or material.

DETECTION OF CRIMINALS BY HAND MARKS. — In a very instructive lecture on the uses of the microscope, delivered at Washington, on April 30th, by Mr. Thomas Taylor, Microscopist of the Department of Agriculture, a view was presented on the screen showing the markings on the palms of the hands and tips of the fingers, and the important suggestion was made that the microscope might be used to effect in the detection of criminals by comparing the marks of a murderer's hands or fingers, which are often impressed in blood stains on the weapons used, with impressions in wax taken from the hands of accused or suspected persons.

ORGANISMS IN ROCHESTER HYDRANT WATER. — The Hemlock Lake water supply of the city of Rochester must be of extraordinary purity, if its ordinary condition is represented by the observations of Prof. S. A. Lattimore of that city, who examined it for the sake of detecting the

cause of the fish-like odor which it possessed last fall. In filtering large quantities of the water he scarcely obtained more than one or two grains of residue from a thousand gallons of water. Of this a large proportion consisted of small particles of clay and sand, and the balance was mainly composed of Diatomaceæ (*Cyclotella operculata*, *Melosira varians*, *Asterionella formosa*, *Fragilaria capucina*, *Navicula cuspidata*, and *Amphora ovalis*), Desmidiaceæ (*Closterium lunula*, and *Staurastrum gracile*), Oscillatoriaceæ (*Oscillatoria autumnalis*), Palmellaceæ (*Botryococcus braunii*), and Entomostraca (*Anurea heptodon*, *Cyclops quadricornis*, *Cypris tristriata*, and *Cetochilus septentrionalis*). Chemical analysis equally indicated the unusual purity of the water, and gave no clew to the cause of its obnoxious odor. The experiment of placing a small quantity of the microscopic algæ from the filter in distilled water resulted in the production of the well-known odor, after covering the mixture from the air for a few hours, just as it had done in a precisely similar experiment by Prof. N. T. Lupton, of Nashville, Tenn., on the water supply of that city. This would strongly confirm the partially accepted belief that this odor, which so often annoys the residents of our cities, is due to some condition, probably the decay and decomposition of the algæ in the water. No remedy is known except exposure to the air, which soon removes the odor.

POWDERED SULPHUR. — Mr. H. G. Hanks presented at a recent meeting of the San Francisco Microscopical Society three slides illustrating the substitution of powdered sulphur for the more costly and pure sublimed sulphur. Sublimed sulphur presents under the microscope a well-marked appearance of globular particles and botryoidal and stalactitic masses, while the powdered sulphur, which appears the same to the naked eye, is shown as angular fragments of irregular size. The powdered article when sold for the sublimed, should be regarded as adulterated, since it contains foreign matter.

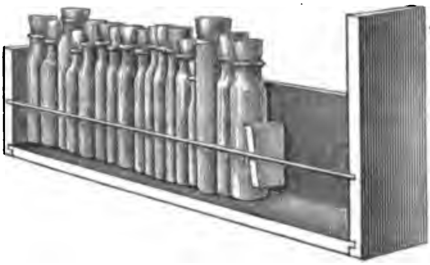
EXCHANGES. — Diatoms from Coorongite, from South Australia, for good mounted objects. Address GALLOWAY C. MORRIS, East Tulpehocken Street, Germantown, Phil.

SCIENTIFIC NEWS.

— Every one who has occasion to use collections of small animals in alcohol knows the inconvenience of handling a large number of little bottles that will neither stand upright nor be still on their sides. If they are kept in boxes a large number have to be taken out one by one to find any particular bottle, and if they are set upon shelves the front ones are sure to be upset while searching among those in the rear. In taking care of a collection contained in several thousand bottles of this kind, the writer has been forced to contrive some method of arranging

them in a small space, and at the same time so that each bottle can be quickly found when wanted, and finally had a case of drawers made which has served the purpose so well that he has thought it worth while to describe it for the benefit of those having charge of similar collections.

One of the drawers is shown in the cut. (Figure 83.) The front, back, bottom, and one side are made of wood one quarter of an inch thick, while the other side consists of a single wire which keeps the bottles in place while allowing their contents to be easily seen. The drawers are a foot long and an inch wide outside, giving a space three quarters of an inch wide for the bottles, which may be from a dram to half an ounce in size. The bottles stand loosely in a single row, and if the drawer is not full, a wedge of wood or cork placed between the wire and the opposite side keeps the end bottles from falling over. The backs and sides of the drawers are made lower than the bottles so that the latter can be more easily taken out and put in. The fronts are made as high as the highest bottles likely to be used, so that when the drawers are placed side by side on a shelf they may close entirely the space between it and the shelf above, and cover the bottles from dust and light. If the width of the shelves is slightly less than the length of the drawers no knobs or handles are needed, and the fronts can be used for labels. The drawers being all of the same size can be changed from one part of the case to another, and the whole collection be rearranged and new specimens introduced in their proper places without changing the bottles from drawer to drawer. Drawers on the same plan might be arranged for bottles of any size not too heavy, and specimens in alcohol be stored in them much more compactly than in the ordinary closets and trays, and at the same time be more easily examined and more quickly found when needed. — J. H. EMERTON.



(FIG. 83.) VIAL HOLDER.

— A new publication designed to elucidate the natural history of Illinois is the Bulletin of the Illinois Museum of Natural History. No. I. contains the following papers: List of Illinois Crustacea, by S. A. Forbes, with a Key; The Tree in Winter, by F. Brendel; Sodic Pinate as a Test for Lime, by J. A. Sewall; Partial Catalogue of the Fishes of Illinois, by E. W. Nelson; Upon Parasitic Fungi, by T. J. Burrill; A List of the Orthoptera of Illinois, by Cyrus Thomas.

— Packard's Half Hours with Insects,[1] which was originally issued in twelve numbers, has lately been published in book form. We desire to correct some typographical and other errors of importance. Page 187, in explanation of Fig. 187, for Bucculating *read* Bucculatrix. Page

[1] Boston: Estes and Lauriat. 1877. 12mo, pp. 384. Illustrated. $2.50.

289, line 23, for *Disippus* read *Archippus*, and in line 25, for *Archippus* read *Disippus*. Page 305, line 13, for *sumac* read *cottonwood*, and on page 306, in explanation of Figure 236, for *sumac gall* read *vagabond gall*.

— L. Prang & Co., Art and Educational Publishers, Boston, Mass., announce the publication of The Yellowstone National Park, and the Mountain Regions of Portions of Nevada, Idaho, Colorado, and Utah. Described by Professor F. V. Hayden, Geologist-in-charge of the U. S. Government Expeditions to the Yellowstone Valley of the Years 1871 and 1872, and of the U. S. Geological and Geographical Survey of the Territories, and Illustrated by Chromo-Lithographic Reproductions of Water-Color Sketches taken by Thomas Moran.

— It is proposed to invite governmental geological surveys, learned societies, and private individuals, throughout the world, to send to the International Exhibition to be held at Paris in 1878 such collections as will make the geological department of that exhibition as complete as possible. In order to take advantage of the collections which may thus be brought together it is moreover proposed to convoke an International Geological Congress, to be held at Paris at some time during the Exhibition of 1878, and to make that congress an occasion for considering many disputed problems in geology. All American geologists interested in this project are invited to communicate with Prof. T. Sterry Hunt, Boston, Mass.

— Among recent zoölogical discoveries of interest is a new species of *Echidna* from New Guinea; a second species of that interesting lizard, *Sphenodon*, in one of the New Zealand Group; a new Leptocardian fish allied to Amphioxus, from Australia, named by Dr. Peters, *Epigomethys cultellus;* while the Persian deer (*Cervus maral*) is regarded by Dr. Severtzoff as identical with the Wapiti (*Cervus Canadensis*).

— A bed of pink coral has been discovered by the captain of the U. S. steamer Gettysburg, on her passage from Fayal to Gibraltar, in latitude 36° 30′ N., longitude 11° 38′ W. The least depth found was 30 fathoms, but the captain has no doubt that the coral comes to the surface at some point near the anchorage. Twenty miles west of the bank a depth of 16,500 feet was found, between this and Cape St. Vincent, 12,000 feet. The bank is rich in valuable coral of light pink shades. Full details of the discovery have been sent by the commander of the Gettysburg to the Navy Department, Washington, by mail.

— Professor F. de Hochstetter, formerly geologist of the Novara Expedition, and a distinguished investigator of the geology of New Zealand, has been appointed Superintendent of the Museum of the Imperial Geological Institute of Austria, and intrusted with its reorganization according to the plan approved by his Majesty. The construction of the new Museum of the Institute is in full progress. Mr. Francis Foetterle, the Vice-Director, has recently died, aged 53 years. He was attached to the Institute since its foundation in 1848.

— A Lyceum of Natural History has been established at Indianapolis, with Prof. E. T. Cox as President, and Mr. H. E. Copeland as Recording Secretary. At the first meeting after organization communications were made by Profs. John Myers, H. E. Copeland, and D. T. Jordan. The latter described the habits of a grasshopper destructive to corn and cotton in the Gulf States, while Professors Jordan and Copeland reported the discovery of the food of the Menomenee, or deep-water white fish of Lakes Superior and Michigan, fresh-water snails (*Physa* and *Limnæa*) having been found in the stomachs. We regret to announce that Mr. Copeland has, since the receipt of this notice, died.

PROCEEDINGS OF SOCIETIES.

PHILOSOPHICAL SOCIETY, Washington. — January 14, 1877. Mr. Gilbert, of Mr. Powell's Survey of the Rocky Mountain Region, read a paper on the Lake Bonneville basin, of which Great Salt Lake is the residue. Outlets to the north had been supposed on theoretical grounds to exist by several geologists, but he believed no one had published any actual identification of an outlet up to the present time. Such an outlet had been examined by him during the past summer, being a narrow cut through a mountain pass, of which the lower portion was formed through part of a bed of limestone while the upper portion of the banks were of gravel, inclined about 30°. The bed of the old channel now formed a continuous marsh. The old beaches which had been traced for many miles differed in level between the northern and southern limits as much as five hundred feet, the distance being about three hundred miles. The southern beaches were higher than those at Salt Lake and the northern ones lower, if observations by the aneroid barometer could be relied on. The speaker thought that this indicated a sinking of the land toward the north since the Glacial epoch, and taken in connection with the changes of outlet at Lake Winnipeg and elsewhere, he considered that it might be inferred that a general sinking of all northern land had taken place since that period.

February 10, 1877. Dr. Billings described some details of the methods employed in investigating the questions of the production of living organisms *de novo*, in suitable fluids from which external germs were excluded, and the "germ theory" of disease. He described a simple and apparently effectual method for protecting the fluid in a wine glass, for instance, by covering the glass with a watch-glass of a little larger diameter, with the convex side upward, the downward curvature of the edges of the watch-glass preventing the lateral introduction of currents of air and germs between the glasses, while the actual access of air was not interfered with. It is of course necessary to destroy anything which might adhere to the glasses before using, by exposing them to a very high temperature.

Major Powell spoke on the philosophy of the North American Indians. The speaker called attention to the fundamental difference in modes of thought which characterize the savage and the civilized man, and illustrated it by numerous examples.

We must, if we would fully understand Indian philosophy, leave that realm of thought where the sun is a great orb swinging in circles through the heavens, where the winds drift in obedience to cosmic laws, where falling stars reveal the constitution of the heavenly spheres, and pass to a lower realm where the sun is regarded as a little beast cowed by the heroic mien of a rabbit, and in very fear compelled to travel on an appointed trail through the firmament, where the wind is but breath, foul or fair, ejected from the belly of a monster, and where the falling star is but the dung of dirty little star-gods.

The savage philosopher believes in a system of worlds (not globes, but localities of existence), the world of this life and the world or region to which he will proceed hereafter. Among the lower tribes these worlds are arranged horizontally or topographically: the world of the hereafter is beyond some river, sea, cañon, chasm, or mountain range, and there is no world of the past, the progenitors of man having come out of the sea or from burrows in the ground. Their hereafter-land is reached by a bridge, a ferry, or a dangerous mountain pass.

Among the higher tribes the worlds are arranged vertically, a world or worlds below and others above. In this stage there is also a past world, that is, humanity came to existence from another land, situated sometimes above, sometimes below; but the righteous always goes in an opposite direction from that by which he came. These worlds communicate by magical ladders. The sun and moon are always personages; meteorological phenomena, acts of persons or of personified animals. All geographic phenomena, remarkable facts of nature, and the habits and customs of savage man,— the origin of all is known, and there is nothing that is not explained in their philosophy.

The theology or system of gods of the North American Indians is not fetichism, though there are many survivals from the fetichistic stage of thought. The gods of all the nomadic tribes are animals, for in all animal nature the nomad sees things too wonderful for him, and from admiration he grows to superstitious reverence, and the animals become his gods. His veneration for the past, so highly developed in the savage, modifies this theology, for it is not the animals of to-day that he reveres, but their ancient prototypes, a god for every race or species of animal. Man is not sharply separated by this system from other animals, but the heroes of the past are the hero-gods of to-day, while the race of man is partly superior, partly inferior to the animal races. Places have their genii or daimons, and all have unlimited power of self-transformation. The generic term for god in most Indian languages is ancient. Individuals,

clans, and tribes have their own special tutelary deity, whose image is their badge or totem.

The land of want, in their hereafter, is always open ; there go the bad souls. The conditions of admission to the land of plenty are vague and variously fixed. There the few living righteous will meet the many good who have died in the past. Who are the good and who the bad? Their standards are as different from ours as their ideas of meteors. The bad man may be he who failed to sacrifice to his tutelar deity the spleen of the last elk killed ; or he who slept on his back the night before the battle, when his gods had taught him to sleep on his belly. It is certain that the Indian philosophy is a stage of progress and not a degeneration of monotheism. Nor does it proceed from classical polytheism, in which human attributes were deified, nor that earlier kind where the forces and phenomena of nature were deified. Their myths are not symbols. The Indian gods are animal gods, and the Indian religion zoölatry, a development from fetichism.

February 24th. Mr. G. K. Gilbert, of Major Powell's Survey, read a paper on Geological Investigations in the Henry Mountains of Utah. These mountains stand in the midst of a plateau region, and form several groups or subgroups, the structure of which is exposed by erosion and denudation. They were formed by an upward flow of lava through horizontal strata, which flow did not reach the surface, but apparently severed the connection between two layers and intruded itself between them in the form of a mound or low cone, the superincumbent strata being forced up without fracture in the form of a dome which reached an angle at the sides of some sixty degrees. The superincumbent strata have been largely removed by natural causes. The facts were very remarkable and not yet fully explained. To these formations or subterranean lava cones he had applied the name of *laculites*.

BOSTON SOCIETY OF NATURAL HISTORY. — February 21st. Mr. C. S. Minot read a paper on the Systematic Position of the Trematodes, and Mr. Scudder made a communication on "perfect" and "imperfect" metamorphoses of insects.

March 21st. Papers were read by Dr. T. M. Brewer, entitled Notes by Captain Bendire on the Birds of Oregon ; and by Mr. Scudder on Polymorphism of our Blue Butterflies.

APPALACHIAN MOUNTAIN CLUB, Boston. — February 14th. Osgood's White Mountain Guide Book was discussed and criticized. Mr. George Dimmock described a trip to Mount Mitchell, in North Carolina, and Miss M. F. Whitman a climb through Tuckerman's Ravine.

March 14th. Prof. J. H. Huntington read a paper on the Source of the Connecticut River.

AMERICAN GEOGRAPHICAL SOCIETY, New York. — March 13th. Dr. W. J. Morton lectured on South African Diamond Fields and the Journey to the Mines.

SCIENTIFIC SERIALS.[1]

Bulletin of the United States Geological and Geographical Survey of the Territories, vol. iii., No. 3. — Comparative Vocabulary of Utah Dialects, by E. A. Barber. Methods of making Stone Weapons, by Paul Schumacher. On a Peculiar Type of Eruptive Mountains in Colorado, by A. C. Peale. Report on the Geology of the Region of the Judith River, Montana, and on Vertebrate Fossils obtained on or near the Missouri River, by E. D. Cope. Palæontological Papers, Nos. 1–5: Descriptions of Unionidæ and Physidæ collected by Prof. E. D. Cope from the Judith River Group of Montana Territory during the Summer of 1876; Descriptions of New Species of Uniones and a New Genus of Fresh-Water Gasteropoda from the Tertiary Strata of Wyoming and Utah; Catalogue of the Invertebrate Fossils hitherto published from the Fresh and Brackish Water Deposits of the Western Portion of North America; Comparison of the North American Mesozoic and Cænozoic Unionidæ and Associated Mollusks with Living Species; Remarks on the Palæontological Characteristics of the Cænozoic and Mesozoic Groups as developed in the Green River Region, by C. A. White. Precursory Notes on American Insectivorous Mammals, with descriptions of New Species, by Elliott Coues. Notes on the Ornithology of the Region about the Source of the Red River of Texas, from Observations made during the Exploration conducted by Lieut. E. H. Ruffner, by C. A. H. McCauley. Catalogue of the Land and Fresh-Water Shells of Nebraska, by S. Aughey. Notes on the Geographical Work of the United States Geological and Geographical Survey of the Territories, by A. D. Wilson.

The Canadian Naturalist, vol. viii., No. 4. — On the Preglacial Geography of the Region of the Great Lakes, by E. W. Claypole. Notes on the Appearance and Migrations of the Locust in Manitoba and the Northwest Territories, Summer of 1875, by G. M. Dawson. Notes on some Geological Features of the Northeastern Coast of Labrador, by H. Y. Hind. Note on Some Recent Changes of Level of the Coast of British Columbia and Adjacent Regions, by G. M. Dawson.

The Monthly Microscopical Journal. — May. The Various Changes caused on the Spectrum by Different Vegetable Coloring Matters, by T. Palmer. Microscopic Aspects of Krupp's Silicate Cotton, by H. J. Slack. The Modifications which the Egg of the [Hooded-Eyed] Medusa undergoes before Fecundation, by A. Giard.

The Geographical Magazine. — May. The Himalayan System by C. R. Markham. M. Potanin's Journey through the Altai Mountains. The Navigation of Smith's Sound as a Route towards the Pole, by G. S. Nares. Map of the La Kuga and of the Alexandra Nile, by H. M. Stanley.

[1] The articles enumerated under this head will be for the most part selected.

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CATASTROPHISM AND EVOLUTION.[1]

BY CLARENCE KING.

WE have come together to-day to do honor to this young, strong institution. We are here that we may make the human circuit complete, and feel the current of a common pride glow from brain to brain. In celebrating the honest, manly growth of the Sheffield Scientific School, among the feelings which animate us veneration for antiquity finds no place. It is denied us to look back into the real past, for the brief lapse of thirty years compasses the life of the school. That short period, however, has amply sufficed to develop, with positive distinctness, the motive and animus of the institution. Its peculiar character is fixed. Reverence for natural truth and the deep, earnest, scientific methods of searching after it are what is taught here; so that we who have passed beyond these doors are gladly welcomed among that resolute band of nature-workers who both propel and guide the great plowshare of science on through the virgin sod of the unknown.

It is centuries too late to define or establish the value of science. Its numberless applications, which find daily expression in the material appointments of life, and serve to refine, to elevate, to render more admirable the mechanism of civilization, have long since put that question at rest. Let us hope that as a means of clearing away the endless rubbish of false ideas from the human intellect, for the lifting of man out of the dominion of ignorance, scientific method and scientific education are acknowledged to be adequate, if not supreme. We may congratulate ourselves, for that victory is won. At last modern society admits that a knowledge of the laws which govern the cognizable universe, and the possession of the only methods which can advance

[1] An address delivered at the Sheffield Scientific School at Yale College, New Haven, June 26, 1877.

that sort of knowledge, presupposes, nay, even develops, an intellect both vital and broad. If in America Science as a mode of education has won her way to the front, it is due, in prominent measure, to the honest training of the Sheffield Scientific School, and time will render this institution its unfailing reward.

Honored by the invitation to address you to-day, I have chosen to present a contribution to the theory of catastrophism and its connection with evolution, feeling that, however slight this contribution may be, as my own it is a direct outgrowth of this school, and that if I turn from the far greater and more attractive achievements of others, from the wealth of literary and philosophic materials which press forward for utterance, and bring here something which I have reached myself, it will afford you a more intimate interest. I have hoped, too, that other graduates might feel as I have, and that year by year men might stand here, fresh from the battle-field of life, out of the very heat of the strife, to tell us of their struggles, and hang the shields they have won along the walls of this temple of science. I ask you then to listen to a plain statement of my views of catastrophism and the evolution of environment.

The earliest geological induction of primeval man is the doctrine of terrestrial catastrophe. This ancient belief has its roots in the actual experience of man, who himself has been witness of certain terrible and destructive exhibitions of sudden, unusual telluric energy. Here in America our own species has seen the vast, massive eruptions of Pliocene basalt, the destructive invasion of northern lands by the slow-marching ice of the glacial period, has struggled with the hardly conceivable floods which marked the recession of the frozen age, has felt the solid earth shudder beneath its feet and the very continent change its configuration. Yet these phenomena are no longer repeated; nothing comparable with them ever now breaks the geologic calm.

Catastrophism is therefore the survival of a terrible impression burned in upon the very substance of human memory. The doctrine was also arrived at in very early times by our modern method of reasoning from marine fossils observed to be entombed in rocky beds far removed from the present seas, — beds which compel the natural inference that they are sea bottoms upheaved. This induction is poetically touched in the Rig Vedas, is stated in scientific method with surprising frequency among the Greeks, and recurs in the writings of most earth-students ever since.

Plutarch in his Morals gives a vivid account of an interview

between an Egyptian priest and wise Solon, who, in the open-mindedness of a truly great man searching after immemorial knowledge, had come to sit at his feet to listen. Calmly and with the few broad touches of a master, in that simple eloquence which comes of really knowing, the priest tells him of the catastrophes of submergence and upheaval which the earth's surface has suffered; and his method was identically ours of to-day. What a picture! Solon the wise, inheritor of the Hellenic culture, master of the polished learning of his country and his day, sitting within the shades of that hoary temple, listening devoutly to the words of one who spoke as out of the dark vault of the past and told how the solid continents were things of a time, born but lately from the womb of the sea.

When complete evidence of the antiquity of man in California and the catastrophes he has survived come to be generally understood, there will cease to be any wonder that a theory of the destructive in nature is an early, deeply rooted archaic belief, most powerful in its effect on the imagination. Catastrophe, speaking historically, is both an awful memory of mankind and a very early piece of pure scientific induction. After it came to be woven into the Sanskrit, Hebrew, and Mohammedan cosmogonies, its perpetuation was a matter of course.

From the believers in catastrophe there is, however, a totally different class of minds, whose dominant characteristic is a positive refusal to look further than the present, or to conceive conditions which their senses have never reported. They lack the very mechanism of imagination. They suffer from a species of intellectual near-sightedness too lamentably common among all grades and professions of men. They are bounded — I might almost say imprisoned — by the evident facts and ideas of their own to-day and their own environment. With that sort of detective sharpness of vision which is often characteristic of those who cannot see far beyond their noses, these men have most ably accumulated an impressive array of geological facts relating to the existing operation of natural laws. They have saturated themselves with the present *modus operandi* of geological energy, and culminating in Lyell have founded the British School of Uniformitarianism.

Men are born either catastrophists or uniformitarians. You may divide the race into imaginative people who believe in all sorts of impending crises, — physical, social, political, — and others who anchor their very souls *in statu quo*. There are men

who build arks straight through their natural lives, ready for the first sprinkle, and there are others who do not watch Old Probabilities or even own an umbrella. This fundamental differentiation expresses itself in geology by means of the two historic sects of catastrophists and uniformitarians. Catastrophism, I doubt not, was the only school among the Pliocene Californians after their families and the familiar fauna and flora of their environment had been swept out of existence by basalts and floods. As understood by archaic man, by the Orientals, the early Egyptians, the Greeks, the Arabs, and indeed until modified within the century by the growing belief in derivative genesis, or by the unbroken continuity of organic life from its first introduction on the planet, catastrophism was briefly this: —

The pre-human history of the planet has been variously estimated in time, from two days — the period assigned by the Koran — to an indefinite extension of ages. The globe having cooled from a condition of igneous fluidity received upon its surface of congealed primitive rock the condensed aerial waters, which formed at first a general oceanic envelope, swathing the whole earth. Out of this universal sea emerged continents; and as soon as the temperature and atmospheric conditions were suitable, low organisms, both of the vegetable and animal kingdoms, were created, and the complex machinery of life set in successful motion.

The great obvious changes in the rocky crust were referred to a few processes: the subaerial decay of continents, delivery of land-detritus by streams into the sea, the spreading out of these comminuted materials upon a pelagic floor, and lastly upheaval, by which oceanic beds were lifted up into subsequent land masses. All these processes are held to have been more rapid in the past than now. Suddenness, world-wide destructiveness, are the characteristics of geological changes, as believed in by orthodox catastrophists. Periods of calm, like the present, suddenly terminated by brief catastrophic epochs, form the groundwork of this school. Successive faunas and floras were created only to be extinguished by general cataclysms.

From all these tenets the modern uniformitarian school dissents only so far as to hold that the processes have not necessarily been more rapidly accomplished than at the rate we witness to-day. The facts of one school are the facts of the other. Both read the record of upheaval and subsidence, of corrugation and crumpling of the great mountain chains alike. One meas-

ures the rate of past geological action by the phenomena of to-day; the other asserts that the present furnishes absolutely no key. This irreconcilable difference finds its most pronounced expression when applied to the past history of life on the planet. If catastrophes extirpated all life at oft-repeated intervals from the time of its earliest introduction, then creation must necessarily have been as often repeated. If this is the case, it is plain that the Creator took pains each time to improve on the lately obliterated forms. If, on the other hand, the uniformitarian biologists are correct in their belief of the descent of all animal life from one or a few primeval types, then catastrophes of a universally destructive character cannot have occurred, and the changes which are proven to have taken place in the earth's surface may have been as moderate and harmless as they maintain. The uniformitarians reject the idea of a rapid and destructive rate of geological revolution in the past, first, because the present course of nature offers no parallel suddenness of action; and, secondly, because they conceive that nature never moves by leaps. They derive great comfort from quoting the well-known saying of Aristotle, that "Nature never does with her greater what she can do with her less." They are especially fond of objecting to catastrophes on account of the vast force necessitated. I confess that this seems to me a singularly fallacious view. Absolutely identical expenditures of energy are required to elevate a continent or depress an ocean basin given distances, whether the operation is instantaneous or infinitely slow. No geologist will hesitate a moment to admit that the question between the schools is not one of geological result, for both read the results alike. I am sure no student of energy will object to my statement that the result requires identical energy, whether employed after the uniformitarian or the catastrophic method. If, as I assert, geological result and the energy to produce it are identical, whichever school is correct, then the only issue between the contestants reduces itself simply and solely to the one question of rate of geological change. In that view, uniformitarianism is the harmless, undestructive rate of to-day prolonged backward into the deep past. This is the belief hinted at by Aristotle and Pythagoras, fought for by Goethe, Lamarck, and Geoffroy St. Hilaire, held to by Hutton, Lyell, and most British geologists, accepted with a lover's credulity by nearly all evolutionists, and finally trumpeted about by the army of scientific fashion followers who would gladly die rather than be caught wearing an obsolete mode or believing in any penultimate thing.

On the other hand, catastrophism of the orthodox sort is the belief in recurrent, abrupt accelerations of geologic rate of crust change, so violent in their rapidity as to destroy all life on the globe. This idea, the mere survival of a prehistoric terror, backed up by breaks in the palæontological record and protected within those safe cities of refuge, the cosmogonies, was fully credited by so recent a great *savant* as Cuvier, and still counts among its soldiers a few of the cast-iron intellects of to-day.

Sweeping catastrophism is an error of the past. Radical uniformitarianism, however, persists, and probably controls the faith of a majority of geologists and biologists. A single extract from so late and so important a book as Croll's Climate and Time will serve to show how strong men still believe in what may be called homœopathic dynamics. Speaking of uniformitarianism, Croll says: "This philosophic school teaches, and that truly, that the great changes undergone by the earth's crust must have been produced, not by convulsions and cataclysms of nature, but by those ordinary agencies that we see at work every day around us, such as rain, snow, frost, ice, and chemical action, etc."

Having reduced the antagonism of the two schools to a question of rate of transference of energy, a single illustration will serve to render clear how, the amount of energy remaining the same, this difference of rate may make the difference between uniformity and catastrophe. Suppose two railway trains of equal weight, each traveling at the rate of fifty miles an hour. On one steam is suddenly shut from the cylinder. The train gradually lessens and lessens its speed, finally coming to rest. It has required a given definite amount of resistance, a numerically expressible amount of work to overcome the motion of the train. The other train at full speed dashes against a bridge pier and is utterly wrecked. The weight, speed, and momentum of the trains are identical, and precisely equal resistance has been expended in bringing them to a stop. In one case the rate of resistance was slow, and acted merely as friction, quite harmlessly to life and after the uniformitarian mode. In the other the rate of resistance was fatally rapid, and its result catastrophe.

Remembering distinctly that uniformitarianism claims one dynamic rate past and present, let us turn to the broader geological features of North America and try to unravel the past enough to test the tenets of the two schools by actual fact. Beneath our America lies buried another distinct continent, — an archæan America. Its original coast-lines we may never be

able fully to survey, but its great features, the lofty chains of the mountains which made its bones, were very nearly coextensive with our existing systems, the Appalachians and Cordilleras. The cañon-cutting rivers of the present Western mountains have dug out the peaks and flanks of those underlying, primeval uplifts and developed an astonishing topography: peaks rising in a single sweep thirty thousand feet from their bases, precipices lifting bold, solid fronts ten thousand feet into the air, and profound mountain valleys. The work of erosion which has been carried on by torrents of the Quaternary age — that is to say, within the human period — brings to light buried primeval chains far loftier than any of the present heights of the globe. Man's enthusiastic hand may clear away the shallow dust or rubbish from an Oriental city, and lay bare the stratified graves of perished communities: it is only a mountain torrent which can dig through thousands of feet of solid rock and let in the light of day on the time-stained features of a long-buried continent.

Archæan America was made up of what was originally ocean beds lifted into the air and locally crumpled into vast mountain chains, which were eroded by torrents into true subaerial mountain peaks. This conversion of sea strata into the early continent is the first record of a series of oscillations in which land and sea successively occupied the area of America. In pre-Cambrian time the continent we are considering sank, leaving some of its mountain tops as islands, and the neighboring oceans flowed over it, their bottoms emerging and becoming continents. This is the second of the recorded oscillations of the first magnitude.

After Archæ-America had began to sink and its bounding land masses to emerge, the conditions on the two sides of the ocean began to show characteristic difference of behavior, — difference in the rate of subsidence, — that very difference of rate which uniformitarianism denies.

Palæ-Pacifis and Palæ-Atlantis were land areas which I conceive to be of continental magnitude, from the vast volumes of sediment brought down by their rivers and poured into the Palæ-American Ocean. American geologists have found the record along the eastern margin of that ocean, namely, the present Appalachian region, so legible that they are agreed as to its main features. There is no plea of illegibility here. The total sediment which fringed the shore of Palæ-Atlantis was about forty-five thousand feet in maximum, but the original ocean, when strata began to gather, was not forty-five thousand feet deep.

That depth and the full accumulation of beds were arrived at by successive subsidences of the sea bottom. The Primordial or earliest Palæozoic along the eastern shore shows evidence of shallow water, which deepened by the occasional sinking of the sea floor. This periodic subsidence went on through the whole Palæozoic time, influencing the Appalachian region, and during the whole coal-bearing period affecting the sea bottom as far as Kansas. Shallow-water evidences are common up to the Carboniferous, after which successive low-level land areas repeatedly occupied the east half of the present Mississippi basin.

This immensely long history of periodic but general subsidence was broken in the northeast by several sudden uplifts, in which the sea strata were so disturbed and inclined that the succeeding beds rested on them unconformably, and in one instance the Green Mountain range was upheaved. The general law on the east side of the Palæ-American Ocean has been the continual inpouring of sediment from Palæ-Atlantis, subsidence of sea bottom, repeated a great number of times, and only locally varied by dislocation and uplifts. A very limited but not unimportant chapter has just been added to the American rock record by the geological exploration of the fortieth parallel; it is the mode of deposition of the Palæozoic rock in the Western United States.

Passing now to the western side of the ocean, we have again the same enormous thickness of thirty or forty thousand feet of Palæozoic beds, but from bottom to top no evidence of disturbance, only uniform proof of deep oceanic deposition. In other words, the two sides differ: one went down by gradual and successive subsidence; the other at once sank so as to form a profound ocean, which, from beginning to end of the vast Palæozoic age, received in its quiet depth the dust of a continent and the débris of an ocean life. I do not say that the western ocean bottom never suffered further subsidence. I only assert that between the two sides the difference of rate was simply immense.

In keeping with the minor and slight movements of subsidence in the east are the changes in the materials of the gathering strata, which are found to vary continually. Here again the contrast between the east and west is marked. All the Palæozoic series in the west consist in the main of a few broad changes between quartzitic and limestone beds, both giving evidence of deep-sea deposition. By way of illustrating these changes of material, let us consider the condition of sedimentation at the west during the Carboniferous age. There we have seven thousand

feet of limestone, for the most part quite free from land-detritus, accumulated with all the evenness and regularity which the most ardent uniformitarian could ask, suddenly followed by an equal amount of pure land-detritus almost free from lime. This sudden change of sediment simply means a sudden physical change, either a cosmical one which recorded itself as a cycle of climate productive of great erosion, or a terrestrial change resulting in such great disturbance of distant land and sea areas as to cause new climate or new avenues of drainage, or some remote coast disturbance which brought about a revolution of oceanic currents. In either case the sudden change, both at the beginning and end of the quartzite period, and the vast scale of the deposit, means a change of rate in the current operation of nature, and an enormous change of rate. The abrupt passage from a period in which little or no land-detritus has entered a sea for millions of years to one when it pours in with relatively marvelous rapidity is certainly not uniformitarian. This phenomenon of sudden change in the broad petrographical features of a composite group of strata is equally true of each sudden break, of which the western Palæozoic has six. Recall that the bottom of all this ocean was a former continent, that along the east the continent went down gradually, by considerable steps it is true, but still by periodic and, perhaps, gradual subsidences. If the uniformitarians can derive any comfort from Eastern America, — and I suppose they justly may, — they are welcome to it. The rate of subsidence in the east, although not unlikely to have been catastrophic as regards the life of the disturbed region, looked at broadly may be called uniformitarian. That on the west was distinctly catastrophic in the widest dynamic sense.

Let us pass now to a remarkable chapter of events which closed the Palæozoic ages. What is now the eastern half of the Mississippi basin had through the coal period often extended itself as a land mass as far west as the Mississippi River, and had as often suffered subsidence and resubmergence. To the west, however, still stretched the open ocean, which, since the beginning of the Cambrian, had, with a single exception, never been invaded by land. At the close of the Palæozoic the two bordering land areas of Atlantis and Pacifis, since the beginning of the Cambrian permanent and perhaps extended continents, began to sink. They rapidly went down, and at last completely disappeared, their places being taken by the present Atlantic and Pacific oceans, while the sea floor of the American ocean, which had

been for the most part permanent oceanic area ever since the submergence of the archæan America, emerged and became the new continent of America, which has lasted with local vicissitudes up to the present. The east and west were, indeed, separated by a mediterranean sea, the sole relic of the American ocean, which now occupied a narrow north and south depression.

In that mediterranean sea, we may say that the conditions have been uniformitarian; that is to say, in the great post-Palæozoic catastrophe that ocean was spared. It remained a body of deep water, its bottom undisturbed by folds or dislocations, and there is no evidence of a cessation of sediments; yet the species which lived there throughout the vast length of the coal period were completely extinguished, and entirely new forms made their appearance. Although spared from the actual physical catastrophe, the effect of the general disturbance of that whole quarter of the globe was thoroughly catastrophic, and exerted a fatal influence upon life far beyond the actual theatre of upheaval.

Passing over the Mesozoic age, which in detail offers much instructive material as to rate of change, we pause only to notice a catastrophe which marked the close of that division of time.

In a quasi-uniformitarian way, 20,000 or 30,000 feet of sediment had accumulated in the Pacific and 14,000 in the mediterranean sea, when these regions, which, during their reception of sediment, had been areas of subsidence, suddenly upheaved, the doming up of the middle of the continent quite obliterating the mediterranean sea and uniting the two land masses into one.

The catastrophe which removed this sea resulted in the folding up of mountain ranges 20,000 and 40,000 feet in height, thereby essentially changing the whole climate of the continent. Of the land life of the Mesozoic age we have abundant remains. Thanks to the palæontologists, the wonderful reptilian and avian fauna of the Mesozoic age is now familiar to us all. But after the catastrophe and the change of climate which must necessarily have ensued, this fauna totally perished. The rate of this post-Cretaceous change was, in other words, catastrophic.

During the Tertiary, fresh-water lakes of wide extent occupied the western half of the continent. Such was the character of the great post-Cretaceous uplift that there were left broad, deep continental basins above the level of the sea. Into these the early Tertiary rivers found their way, creating extended lakes in which accumulated strata rivaling in importance the deposits

of the great oceans. The whole history of the Tertiary is that of the accumulation of thick sedimentary series in fresh-water lakes, accompanied by gradual and periodic subsidence, carried on smoothly and uniformly up to a certain point, and then interrupted by a sudden, mountain-building upheaval, which drained the lakes and created new basins. The five minor catastrophes which have taken place in the western half of America during the Tertiary age have never resulted in those broader changes which mark the close of the Archæan, the Palæozoic, and the Mesozoic ages. They never broke the grander outline of the continent. They were, however, of such an important scale as to very greatly vary the conditions of half the continent. I may cite the latest important movement, which took place probably within the human epoch, certainly at the close of the great Pliocene lake period of the west. The whole region of the great plains, as far north as we are acquainted with their geology, and southward to the borders of the Gulf, was occupied by a broad lake which existed through the Pliocene period, having always a subtropical climate. In that lake, beds 1000 to 1200 feet thick had accumulated, when suddenly the level floor was tilted, causing a difference of height of 7000 feet between the south and west shores, making the great inclined surface of the present plains, and utterly changing the climate of the whole region. Not a species survived.

I have thus hastily mentioned a few of the most important geological crust changes in America whose rates are demonstrably catastrophic. Besides surface changes involving subsidence, upheaval, faulting, and corrugation, all of which may be executed on a scale or at a rate productive of destruction of life, catastrophes may be brought about by sudden great changes of climate or by intense volcanic energy. In the latter field there are obviously no catastrophes of the first order. Geological maps of the globe have progressed far enough to demonstrate that considerable areas are, and always have been, free from actual ejection of volcanic materials. On the contrary, numerous great regions, notably the western third of our own continent and the shores of the Pacific, were once literally deluged with volcanic fires. An examination of the ejected rock shows that modern eruptions, by which the volcanic cones of the present period are slowly built up from slight overflows piling one upon another, are not the method of the great Miocene and Pliocene volcanic periods. There were then outbursts hundreds of miles in extent, in

which the crust yawned and enormous volumes of lava rolled out, overwhelming neighboring lands. Volcanoes proper are only isolated chimneys, imposing indeed, but insignificant when compared with the gulfs of molten matter which were thrown up in the great massive eruptions. Between the past and present volcanic phenomena there is not only a difference of degree but of kind. It is easy to read the mild exhibition of existing volcanoes as a uniformitarian operation, namely, the growth of cones by slight accretions; but such reasoning is positively forbidden in the past.

If poor, puny little Vesuvius could immortalize itself by burying the towns at its feet, if the feeble energy of a Lisbon earthquake could record itself on the grave-stones of thousands of men, then the volcanic period in Western America was truly catastrophic. Modern vulcanism is but the faint, flickering survival of what was once a world-wide and immense exhibition of telluric energy, one whose distortions and dislocations of the crust, whose deluges of molten stone, emissions of mineral dust, heated waters, and noxious gases could not have failed to exert destructive effect on the life of considerable portions of the globe. It cannot be explained away upon any theory of slow, gradual action. The simple field facts are ample proof of the intensity and suddenness of Tertiary vulcanism.

Of climate catastrophes we have the record of at least one. When the theory of a glacial period came to be generally accepted, and the destructive effects of the invasion of even middle latitudes by polar ice were realized, especially when the devastating effects of the floods which were characteristic of the recession of the ice came to be studied, uniformitarianism pure and simple received a fatal blow. I am aware that British students believe themselves justified in taking uniformitarian views of the bowlder-till, but they have yet to encounter phenomena of the scale of our Quaternary exhibitions.

A most interesting comparison of the character and rate of stream erosion may be obtained by studying in the western Cordilleras, the river work of three distinct periods. The geologist there finds preserved and wonderfully well exposed, first, Pliocene Tertiary river valleys, with their bowlders, gravels, and sands still lying undisturbed in the ancient beds; secondly, the system of profound cañons, from 2000 to 5000 feet deep, which score the flanks of the great mountain chains, and form such a fascinating object of study, and not less of wonder, because the

gorges were altogether carved out since the beginning of the glacial period; thirdly, the modern rivers, mere echoes of their parent streams of the early Quaternary age. As between these three, the early Quaternary rivers stand out vastly the most powerful and extensive. The present rivers are utterly incapable, with infinite time, to perform the work of glacial torrents. So, too, the Pliocene streams, although of very great volume, were powerless to wear their way down into solid rock thousands of feet, at the rapid rate of the early Quaternary floods. Between these three systems of rivers is all the difference which separates a modern (uniformitarian) stream and a terrible catastrophic engine, the expression of a climate in which struggle for existence must have been something absolutely inconceivable when considered from the water precipitations, floods, torrents, and erosions of to-day.

Uniformitarians are fond of saying that give our present rivers time, plenty of time, and they can perform the feats of the past. It is mere nonsense in the case of the cañons of the Cordilleras. They could never have been carved by the pigmy rivers of this climate to the end of infinite time. And, as if the sections and profiles of the cañons were not enough to convince the most skeptical student, there are left hundreds of dry river-beds, within whose broad valleys, flanked by old steep banks and eloquent with proofs of once-powerful streams, there is not water enough to quench the thirst even of a uniformitarian. Those extinct rivers, dead from drought, in connection with the great cañon system, present perfectly overwhelming evidence that the general deposition of aerial water, the consequent floods and torrents, forming as they all do the distinct expression of a sharply-defined cycle of climate, as compared either with the water phenomena of the immediately preceding Pliocene age or with our own succeeding condition, constitute an age of water catastrophe whose destructive power we only now begin distantly to suspect.

I have given you what in my belief are sound geological conclusions, the want of time alone causing me to waive the slow production of proofs. I believe I am fully prepared to sustain the assertions, first, that the rate of physical change progressing to-day in all departments of terrestrial action is inadequate to produce the grander features of American geological history; secondly, that in the past, at intervals, the dynamic rate has been so sharply accelerated as to bring about exceptional results; thirdly, that these results have been catastrophic in their effect

upon the life of America and the bounding oceans. I have called the revolutions in the American area catastrophic because any disturbances of land or sea, of the described scale, intensity, and rapidity, could not fail to have a disastrous effect on much of the organic world. The uniformitarian school would accept these crust changes with unruffled calmness; they would read the record exactly as a catastrophist might, only they would assume unlimited time and their inch-by-inch process. The analogy of the present, they say, is against any acceleration of rate in the past, and besides, the geological record is a very imperfect document which does not disprove our view. In plain language, they start with a gratuitous assumption (vast time), fortify it by an analogy of unknown relevancy (the present rate), and serenely appeal to the absence of evidence against them as proof in their favor. The courage of opinion has rarely exceeded this specimen of logic. If such a piece of reasoning were uttered from a pulpit against evolution, biology would at once take to her favorite sport of knuckle-rapping the clergy in the manner we are all of us accustomed to witness. In forbidding us to look for past rates of change differing from the present, the British uniformitarians have tied the hands of the science. By preaching so eternally from the text of "imperfection of the geological record," they have put blinders on the profession. A few more such doctrines will reduce the science to a corpse, around which teleologists and biologists might hold any sort of funeral dance their fancy dictated. Now, because the record is not altogether made out is no proof whatever that it never will be. There was once a discovery of a very small piece of evidence, the Rosetta Stone, which served as a key to a vast amount of previously illegible material. Geology, if not strangled in its own house, will, in my belief, go on and dig up enough Rosetta Stones to translate the strata into a precise language of energy and time.

As yet we have no means, beyond mere homotaxial comparison, for relating the crust movement of distant regions. I do not, however, despair of our being able to correlate the movements and revolutions of different continents. At present, old-fashioned catastrophes, involving repeated world-wide destruction of all life, such cataclysms as Cuvier believed in, and which occasioned the revolt of the biologists of his time, are justly repudiated. On the other hand, the mild affirmations of the uniformitarians, that existing rates of change and indefinite time

are ample to account for the past, are flatly and emphatically contradicted by American facts. With our present light, geological history seems to be a dovetailing together of the two ideas. The ages have had their periods of geological serenity, when change progressed in the still, unnoticeable way, and life through vast lapses of time followed the stately flow of years, drifting on by insensible gradations through higher and higher forms, and then all at once a part of the earth suffered short, sharp, destructive revolution, as unheralded as an earthquake or volcanic eruptions. The sciences are as independent as bodily organs; they are the vitals of human knowledge. A fallacy lodged in one produces functional disturbance of the others. It was the error of universal and extreme catastrophes which so violated the conceptions of Lamarck, Goethe, and St. Hilaire as to draw out their earnest protest, and as usual they urged the pendulum past the golden mean of truth over to the counter error of extreme uniformitarianism. This later error has been confidently built in as one of the corner-stones of the imposing structure of evolution. I believe the crumbling, valueless nature of this foundation will yet make itself felt in the ruin of just so much as the builders have rested upon it.

If the vicissitudes of our planet have been as marked by catastrophes as I believe, how does that law affect our conceptions of the development of life and the hypothesis of evolution? Man, whatever the drift of life or philosophy, returns with restless eagerness, with pathetic anxiety, to the enigma of his own origin, his own nature, his own destiny. With reverence, with levity, with faith, with doubt, with courage, with cowardice, by every avenue of approach, in every age, the same old problem is confronted. We pour out our passionate questionings, and hearken lest mute nature may this time answer. But nature yields only one syllable of reply at a time.

Darwin, who in his day has caught the one syllable from nature's lips, advances always with caution, and although he practically rejects does not positively deny the existence of sudden great changes in the earth's history. Huxley, permeated in every fibre by belief in evolution, feels that even to-day catastrophism is not yet wholly out of the possibilities. It is only lesser men who bang all the doors, shut out all doubts, and flaunt their little sign, "Omniscience on draught here." It must be said, however, that biology, as a whole, denies catastrophism in order to save evolution. It is the common mistake of biologists to as-

sume that catastrophes rest for their proof on breaks in the palæontological record, meaning by that the observed gaps of life or the absence of connecting links of fossils between older and newer sets of successive strata. There never was a more serious error. Catastrophes are far more surely proved by the observed mechanical rupture, displacement, engulfment, crumpling, and crushing of the rocky surface of the globe. Granted that the evidence would have been slightly less perfect had there been no life till the present period, still the reading would have been amply conclusive. The palæontological record is as imperfect as Darwin pleads, but the dynamic record is vitiated by no such ambiguity.

It is the business of geology to work out the changes of the past configuration of the globe and its climate; to produce a series of maps of the successive stages of the continents and ocean basins, but it is also its business to investigate and fix the rates of change. Geology is not solely a science of ancient configuration. It is also a history of the varying rates and mode of action of terrestrial energy. The development of inorganic environment can and must be solved regardless of biology. It must be based on sound physical principles, and established by irrefragable proof. The evolution of environment, a distinct branch of geology which must soon take form, will, I do not hesitate to assert, be found to depend on a few broad laws, and neither the uniformitarianism of Lyell and Hutton, Darwin and Haeckel, nor the universal catastrophism of Cuvier and the majority of teleologists, will be numbered among these laws. In the dominant philosophy of the modern biologist there is no admission of a middle ground between these two theories, which I, for one, am led to reject. Huxley alone, among prominent evolutionists, opens the door for union of the residua of truth in the two schools, fusing them in his proposed evolutional geology. Looking back over a trail of thirty thousand miles of geological travel, and after as close a research as I am capable, I am impelled to say that his far-sighted view precisely satisfies my interpretation of the broad facts of the American continent.

The admission of even modified catastrophe, namely, suddenly-destructive, but not all-destructive change, is, of course, a downright rejection of strict uniformitarianism. I comprehend the importance of the position, how far-reaching and radical the logical consequences of this belief must be. If true, it is nothing less than an ignited bomb-shell thrown into the camp of

the biologists, who have tranquilly built upon uniformitarianism, and the supposed imperfection of the geological record. I quote a few of their characteristic utterances. Lamarck, in his Philosophie Geologique, 1809, says, "The kinds or species of organisms are of unequal age, developed one after another, and show only a relative and temporary persistence. Species arise out of varieties. . . . In the first beginning only the very simplest and lowest animals and plants came into existence; those of a more complex organization only at a later period. The course of the earth's development and that of its organic inhabitants was continuous, not interrupted by violent revolutions. . . . The simplest animals and the simplest plants, which stand at the lowest point in the scale of organization, have originated and still originate by spontaneous generation." Darwin[1] says: "We must be cautious in attempting to correlate as strictly contemporaneous two formations, which include few identical species, by the general succession of their forms of life. As species are produced and exterminated by slowly acting and still acting causes, and not by miraculous acts of creation and by catastrophes. . . . And again, for my part, following out Lyell's metaphor, I look at the natural geological record as a history of the world imperfectly, kept and written in a changing dialect; of this history we possess the last volume alone, relating only to two or three countries. Of this volume, only here and there a short chapter has been preserved; and of each page only here and there a few lines. Each word of the slowly changing language in which the history is written, being more or less different in the successive chapters, may represent the apparently abruptly changed forms of life entombed in our consecutive but widely separated formations. On this view, the difficulties above discussed are greatly diminished, or even disappear."

It is unnecessary to repeat here the well-known views of Lyell. How far biologists have learned to lean on his uniformitarian conclusions may be seen from the following quotation from Haeckel,[2] "He [Lyell] demonstrated that those changes of the earth's surface which are still taking place before our eyes are perfectly sufficient to explain everything we know of the development of the earth's crust in general, and that it is superfluous and useless to seek for mysterious causes in inexplicable revolutions. He showed that we need only have recourse to the hypothesis of

[1] Origin of Species, p. 522.

[2] History of Creation, vol. i., pages 127–129.

exceedingly long periods of time, in order to explain the formation of the crust of the earth in the simplest and most natural manner, by the means of the very same causes which are still active. Many geologists had previously imagined that the highest chains of mountains which rise on the surface of the earth could owe their origin only to enormous revolutions transforming a great part of the earth's surface, especially to colossal volcanic eruptions. Such chains of mountains as those of the Alps or the Cordilleras were believed to have arisen direct from the fiery fluid of the interior of the earth through an enormous chasm in the broken crust. Lyell, on the other hand, showed that we can explain the formation of such enormous chains of mountains quite naturally by the same slow and imperceptible risings and depressions of the earth's surface which are still continually taking place, and the causes of which are by no means miraculous. Although these depressions and risings may perhaps amount only to a few inches, or at most a few feet, in the course of a century, still in the course of some millions of years they are perfectly sufficient to raise up the highest chains of mountains without the aid of mysterious and incomprehensible revolutions. . . . We have long known, even from the structure of the stratified crust of the earth alone, that its origin and the formation of neptunic rocks from water must have taken at least several millions of years. From a strictly philosophical point of view, it makes no difference whether we hypothetically assume for this process ten millions or ten thousand billions of years. Before us and behind us lies eternity." This is even bolder than Hutton, who says: "I take things as I find them at present; and from these I reason as regards that which must have been. . . . A theory, therefore, which is limited to the actual constitution of this earth, cannot be allowed to proceed one step beyond the present order of things."

The successive hypotheses which, linked together, form the chain of evolution are, first, the nebular hypothesis; second, spontaneous generation; third, natural selection. It is only with the last that geology has intimate relation. The general theory of a derivative genesis or the descent of all organisms by the various modes of reproduction from one or a few primitive types which came into existence by spontaneous generation was believed long before the Darwinian theory was advanced. Darwin's great contribution was the modus operandi of derivative genesis. It was a mode of accounting for the in-

finite branching out and differentiation of the complex forms of life from the primitive germs. His theory is natural selection, or the survival of the fittest, a doctrine which, left where Darwin leaves it, has its very roots in uniformitarianism.

Analyzed into its component parts, natural selection resolves, as is well known, into two laws, hereditivity and adaptivity: first, the power on the part of organisms to transmit to offspring their own complex structure down to the minutest details; and, secondly, the power by slight alterations on the part of all individuals to vary slightly in order to bring themselves into harmony with a changed environment. When we bring geology into contact with Darwinism, it is evident that hereditivity is out of the domain of our inquiry; it is not the engine of change, it is the conservator of the past; but the companion law of adaptivity, or the accommodation to circumstances, is one which depends half upon the organism and half upon the environment; half upon the vital interior, half upon the pressure which the environment brings to bear upon it. Now, environment, as conclusively shown by biologists, is a twofold thing, a series of complicated relationships with contemporaneous life, but, besides, with the general inorganic surrounding, involving climate and position upon the globe. Preoccupied with the strictly biological environment, namely, the intricate relation of dependence of any species upon some of its surrounding species, biologists have signally failed to study the power and influence of the inorganic or geologic environment. The actual limits of the influence of physical conditions on life are practically unknown. In America more than in Europe this branch of inquiry has begun to attract notice, but it is yet in its swaddling-clothes. It has lain little and weak from inanition, while the favorite child, Natural Selection, has been fed into a plethoric, overgrown monster. Darwin, Wallace, Haeckel, and the other devoted students of natural selection have brought to light the most astonishingly complex struggle for existence, everywhere progressing — the fiercest battle for life and for subsistence, for standing-room, for breath. Some species gain, others lose, some go down to annihilation. In this battle they seea dequate cause for all the great, highly organized products of the millions of years since life began. From their logic, you and I are conquerors who have mounted to manhood by treading out the life of infinite generations. We are what we are because this brain and this body form the most effective fighting-machine the dice-box of ages has thrown.

From their conclusions and philosophy let us turn, but with no revolt of prejudice, no rebound of a happier intuition, for this is a question of science. Those who defend the stronghold of natural selection are impregnable to the assaults of feeling. They are dislodged only by the solid projectiles of fact, and to facts cast in the mold of nature they count it no dishonor to surrender. If, as I have said, the evolution and power of environment have been singularly neglected studies, if biologists have allowed the splendor of their achievements within the province of life to blind them to the working of that other and no less important side of the problem, what then is the general relation in time and space of the inorganic environment to life?

Let us first acknowledge frankly that the present and later parts of the Quaternary period are uniformitarian; that the changes going on in organic life now do obey the great law of survival of the fittest, and that if the uniformitarians were true in making of the past a mere infinite projection of the present, then the biologists would have based their theories on a solid foundation, and my protest would have no weight. Let us go further and cordially admit that in all periods of uniformity the progress of life would adjust itself to its surroundings, and the war of competitive extermination become the dominant engine of change and development. This is giving full credit to the greatness of the biological result, and simply asserts that they who achieved it are sound as far as the analogy of present uniformity may be permitted to go. But uniformity has not been the sole law; it has, as we have seen, been often broken by catastrophes, — that is, by accelerated rate of change. Rapid physical change has been, it seems to me, the more important of the two conditions of the past, the one whose influence will at last prove to have been the dominant one in life change.

Has environment, with all the catastrophic changes, been merely passive as regards life? It has either had no effect, or has restrained the progress of evolution, or has advanced it, or its influence has been as varied as its own history, — now by the development of favoring conditions accelerating vital progress, now suddenly exterminating on a vast scale, again urging evolution forward, again leaving lapses of calm in which species took the matter into their own hands and worked out their own destiny. It is only through rapid movements of the crusts and sudden climatic changes, due either to terrestrial or cosmical causes, that environment can have seriously interfered with the evolution of

life. These effects would, I conceive be, first, extermination; secondly, destruction of the biological equilibrium, thus violating natural selection; and thirdly, rapid morphological change on the part of plastic species. When catastrophic change burst in upon the ages of uniformity, and sounded in the ear of every living thing the words "change or die," plasticity became the sole principle of salvation. Plasticity, then, is that quality which, in suddenly enforced physical change, is the key to survival and prosperity. And the survival of the plastic, that is of the rapidly and healthily modifiable during periods when terrestrial revolution offers to species the rigorous dilemma of prodigious change or certain death, is a widely different principle from the survival of the fittest in a general biological battle during terrestrial uniformity. In one case it is an accommodation between the individual organism and inorganic environment, in which the most yielding and plastic lives. In the other it is a Malthusian death struggle, in which only the victor survives. At the end of a period of uniformitarian conditions, the Malthusian conqueror, being the fittest, would have won the prize of survival and ascendency. Suppose now an interval of accelerated change. At the end only the most plastic would have deviated from their late forms and reached the point of successful adaptation, which is survival in health. Whatever change takes place by natural selection in uniformitarian ages, according to Darwin, advances by spontaneous, aimless sporting and the survival of those varieties best adapted to surrounding conditions, and of these conditions the biological relations are by far the most important of all. By that means, and by that alone, it is asserted, species came into existence, and inferentially all the other forms from first to last. This is the gospel of chance.

If the out-door facts of American geology shall be admitted to bear me out in my assertion of catastrophes, and if the epochs of maximum vital change do, as I hold, coincide with the epochs of catastrophes, then that coincidence should be directly determinable in the field. I confidently assert that no American geologist will be able to disprove the law that in the past every one of the great breaks in the column of life coincide with datum points of catastrophe. It remains to be determined how far this coincidence is the expression of environmental cause, responded to in terms of vital effect.

From a comparison of the list and character of geological changes in America with those mysterious lines across which no

species march, I feel warranted in harboring the belief that catastrophe was an integral part of the cause; changed life, the effect. Biologists are accustomed to explain the cause of a great gap like that which divides the Palæozoic and Mesozoic life by an admission that the Palæozoic forms ceased to live, but that the succeeding changed forms at the beginning of the Mesozoic were not the local progeny, greatly modified by catastrophic change, but merely immigrants from some other conveniently assumed country. They succeed in rendering this highly probable, if not certain, in many instances. But they are estopped from always advancing this migration theory. Greek art was fond of decorating the friezes of its sacred edifices with the spirited form of the horse. Times change; around the new temple of evolution the proudest ornament is that strange procession of fossil horse skeletons, among whose captivating splint-bones and general anatomy may be descried the profiles of Huxley and Marsh. Those two authorities, whose knowledge we may not dispute, assert that the American genealogy of the horse is the most perfect demonstrative proof of derivative genesis ever presented. Descent they consider proved, but the fossil jaws are utterly silent as to what the cause of the evolution may have been.

I have studied the country from which these bones came, and am able to make this suggestive geological commentary. Between each two successive forms of the horse there was a catastrophe which seriously altered the climate and configuration of the whole region in which these animals lived. Huxley and Marsh assert that the bones prove descent. My own work proves that each new modification succeeded a catastrophe. And the almost universality of such coincidences is to my mind warrant for the anticipation that not very far in the future it may be seen that the evolution of environment has been the major cause of the evolution of life; that a mere Malthusian struggle was not the author and finisher of evolution; but that He who brought to bear that mysterious energy we call life upon primeval matter bestowed at the same time a power of development by change, arranging that the interaction of energy and matter which make up environment should, from time to time, burst in upon the current of life and sweep it onward and upward to ever higher and better manifestations. Moments of great catastrophe, thus translated into the language of life, become moments of creation, when out of plastic organisms something newer and nobler is called into being.

ON CHANGES OF HABIT AMONG WOODPECKERS.[1]

BY SAMUEL CALVIN.

IT has long been known to naturalists that certain genera of woodpeckers have wholly or partly adopted habits quite inconsistent with those generally suggested when we think of the group.

Within the past two or three years I have frequently had the pleasure of observing the red-headed woodpecker in the act of catching flies on the wing. Seating itself on the summit — not on the side — of some fence-stake or other elevated perch, it watches, as does the kingbird, for passing insects. Having singled out the desired victim from among many not worth catching, it darts forward, catches it, and returns, usually to the same perch, to wait for the next. This any one may see repeated over and over again by the same individual, showing that it is no mere chance departure from woodpeckerian dignity into which the bird is inadvertently betrayed, but is rather one of the ordinary and settled practices resorted to in procuring food.

The movements in the air of this woodpecker are very similar to those of the kingbird; it executes the gyrations and peculiar gymnastics necessary to follow the dodging insect with great adroitness.

What is the meaning of all this? The barbed tongue, stout, straight bill, muscular neck, and structural adaptations for climbing, all point to a different mode of life. None of them, certainly, can be regarded as rendering the bird any special fitness for fly-catching. It must be that the struggle for life among bark-searching birds has recently — within the past two or three geological epochs — become more severe, so much so as to drive some of them to the adoption of other habits, quite regardless of structural fitness. The golden-winged woodpecker (*Colaptes auratus*), as all know, has been driven from the trees to feed largely on the ground. Its near relative (*Colaptes campestris*), of some parts of South America, frequents open plains, and, according to the testimony of competent observers, is never seen on trees at all.

As bearing upon these changes of habit, and perhaps furnishing a suggestion in part of their compelling cause, it is interesting to note that quite a number of the perching birds have settled into the questionable habit of systematically poaching upon the special domain of the woodpecker. Among the war-

[1] Read before the Iowa Academy of Science, May 3, 1877.

blers, even, we have in Iowa the black and white creeper (*Mniotilta varia*), that excels most woodpeckers in ability to scramble over and thoroughly search the bark of a tree. The whole family of creepers, the Certhias, — represented with us by the little brown creeper, (*Certhia familiaris*), — is also able to compete successfully with woodpeckers on their own ground. But perhaps the most expert of all the perchers that have taken to clambering over trees are the nut-hatches. A very common one is the *Sitta Carolinensis*, which may be seen almost any day on trees in our streets and door-yards. Its nervous and rapid movements, its slaty-colored back, and black crown must be familiar to all. It moves upward and downward with equal facility and always head foremost; the upper and under side of a limb are explored with equal ease; rarely resting, it frisks up and down, round and round, over and under, in and out, finishing a tree and ready for the next long before the average woodpecker would be able to collect himself and get fairly under way.

The habit of climbing is certainly an ancient one among woodpeckers. All the genera have the feet, tongue, bill, tail feathers, etc., modified in substantially the same way, and this would point to an ancestor that practiced their characteristic habits before the modern genera began to diverge. On the other hand, we may fairly conclude that since climbing is rather exceptional among perchers, the few groups that practice it have acquired it at a comparatively recent date, and it is quite possible that competition with climbing perchers may constitute a large share of the disturbing cause which has compelled certain woodpeckers of late to abandon the habits of their ancestors.

It is worthy of note, too, that the species which have suffered most in this competition are among the largest of our Northern woodpeckers. With the exception of the pileated woodpecker, they are in fact the largest, and furnish another illustration of the fact that nature looks with but small favor upon mere bulk. A little nerve often outweighs a large amount of muscle.

The pileated woodpecker frequents deep forests, and I have never been able to observe its habits. Its retirement, however, has withdrawn it from competition with the more agile forms we have noticed, and if food is only sufficiently abundant there is no immediate necessity for giving up its ancestral habits. The red-head and flicker, preferring open glades, are brought into constant and active competition with more sprightly and energetic climbers, and find themselves obliged to adopt other habits in great measure, or perish.

ABORIGINAL SHELL ORNAMENTS, AND MR. F. A. BARBER'S PAPER THEREON.

BY R. E. C. STEARNS.

IN the May number of the AMERICAN NATURALIST (page 271) Mr. E. A. Barber, in an article on Stone Implements and Ornaments from the Ruins of Colorado, Utah, and Arizona, remarks: "The marine shells which were converted into beads by the ancient tribes, so far as ascertained by the investigations of the United States Geological Survey, during the summer of 1875, were the *Oliva* and (possibly) the *Busycon* or *Murex*. . . . Figure 7, Plate I., represents a specimen of the *Oliva biplicata* (probably), although the shell is so weather worn that the specific characteristics are almost entirely obliterated. Still it strongly resembles this species of the Pacific coast, and is very likely the same." In a foot-note Mr. Barber says that "it may be *Olivella gracilis*."

The figure referred to certainly *does not* strongly resemble *O. biplicata*, and if reasonably accurate, the specimen from which the figure was drawn does not belong to the said species. It may be either *O. gracilis* or *O. dama*,[1] common Gulf of California forms, not found as yet north of latitude 25° N. on the ocean side of Lower California, or it way be *O. bœtica*, which like *O. biplicata* is a northern species, not found in the Gulf.

There is no species of *Busycon* on the Pacific Coast, and *Murex*,[2] though found in the Gulf, seldom occurs on the outer shore north of Cape St. Lucas, and is rare at the cape. "*Murex*" as used here is exceedingly vague, for the *Muricidæ* are so largely represented upon this part of the West American or more exactly West Mexican coast, and includes so many well-marked groups, that the name of the genus, subgenus, or group should be given.

The importance of an accurate determination of species of shells, in connection with the "ancient tribes" of the region named in Mr. Barber's paper, and as related under similar conditions to ethnological questions, ppon a brief review of the points involved, will be seen at a glance.

If the beads or ornaments were made of the shells of *Murex* and *Olivella*, either *O. gracilis* or *O. dama*, Gulf forms, it in-

[1] Cooper in Geog. Cat., sp. 732, credits San Pedro, Cal., with this form, but it has not been verified.

[2] Whether Murex proper or the markedly prominent group, *Phyllonotus*, is not stated by Mr. Barber.

dicates a line of communication, intercourse, traffic, and possibly migration by the way of the Gulf of California and the Colorado River. If the Olivella is *O. biplicata*, and the beads, which it is said are as thin as a wafer and of the circumference of an ordinary pea, are what I suspect,[1] then we have a right to infer that these interior people were in communication directly or indirectly with the California tribes north of what is now known as Lower California. If any of the shell ornaments are made of some species of *Busycon*, then communication with the Gulf of Mexico is implied.

If all of the shells cited by Mr. Barber, and involved in doubt by the indefiniteness of his paper, are actually represented in the material collected, then the whole question as to the origin, distribution, and characteristics of the extinct tribes of Colorado, Utah, and Arizona is still further complicated, for it indicates intercourse, traffic, and perhaps migration in three directions, and the relations of these interior people with the maritime or coast tribes of both sides of the continent, or through, or with intermediate tribes, become a factor which has to be duly weighed and considered, the importance of which is only equaled by its complexity.

It is highly probable that an examination of the shell ornaments mentioned by Mr. Barber by some competent conchologist familiar with West American shells and with the ethnological material of the California mounds would authenticate the species of which Mr. Barber's shell ornaments are made, and it is to be hoped that he will have them carefully examined, and state not only the species but the authority for their determination. By doing so he will add much to the value of his researches, and the object of this criticism will be accomplished.

THE LONG-JAWED GOBY.

BY W. N. LOCKINGTON.

THE somewhat inelegant title I have given to this curious little fish cannot be said to be its vernacular name, since, like the greater portion of the creatures that inhabit the world, it has not as yet acquired a commonly received name in our language, and the only name it has a perfect right to is the Latin one bestowed by its first describer, Dr. J. G. Cooper, namely, *Gillichthys mirabilis*.

[1] Similar beads are found in the California mounds, and are simple concavo-convex disks cut out of the body whorl of *O. biplicata*.

As *Gillichthys* is simply a compound of the name of a celebrated American icthyologist with the Greek word for a fish, and *mirabilis* means nothing more than "wonderful" or "curious," this Latin name gives no idea of the fish, so it will be as well to call it the long-jawed goby, as its chief peculiarity consists in its tremendous length of jaw.

A garpike has a long jaw, and so has an alligator, and it is not unlikely that the title will call up in the minds of some who read this the idea of a terrible mouth, armed with bristling rows of teeth. This would be a great mistake, for our little fish has no teeth worth bragging about, and does not open his mouth any wider than a well-behaved fish should do. The great difference between his long jaws and those of a garpike is that the latter's project forwards, while those of our goby are prolonged backwards immensely.

The long-jawed goby was discovered by Dr. Cooper in the bay of San Diego, among seaweed growing on small stones at the wharf, and in such a position that it must have been out of water from three to six hours daily, though kept moist by the seaweed.

Dr. Cooper's two specimens held their place as curiosities among the *olla podrida* of the Museum of the California Academy of Sciences for several years, no one suspecting that the fish was a resident of the neighborhood of San Francisco, as no specimens were ever found in the fish-market.

A few months ago two specimens were brought to the Academy by one of its members, who stated that he had obtained them from some Chinamen who lived on the marshes near the mouth of San Antonio Creek, Oakland; that they were found by digging in the mud beside the brackish creeks that intersect the marshes, and that the Chinamen eat them, and find them good.

These specimens were not so large as those presented by Dr. Cooper, and differed from them in the much smaller proportionate length and width of the singular cartilaginous expansion of the maxillary bone, which, uniting with a membrane from the lower jaw, continues backwards as a long fold or pouch as far as, or even beyond, the gill-covers, and gives to the fish its unique appearance.

On a more recent occasion a single *Gillichthys*, much larger than any of those before mentioned, was presented by a gentleman, who said that the fish, which was new to him, was abundant upon his ranch in Richardson's Bay, in the northern part of the bay of San Francisco; that the Chinamen dug them up and

ate them, and that he had had about eleven specimens cooked, and found them good, tasting, he thought, something like eels, the twelfth specimen he had preserved in alcohol, in the interest of natural science. This gentleman had the opportunity of observing something of the mode of life of these fishes, and informed us that their holes, excavated in the muddy banks of tidal creeks, increase in size as they go downwards, so that the lower portion is below the water level, or at least sufficiently low to be kept wet by the percolation from the surrounding mud.

When the various specimens now acquired were placed side by side, the difference in the relative length of their jaws was very conspicuous, for while in the smallest it was about one-fifth of the total length, in the largest it exceeded one-third.

As the fish had now been found in two places in the bay, I thought I would try to find it also, and to this end sallied out one morning, armed with a spade, and commenced prospecting in a marsh at Berkeley, not very far from the State University. For a long time I was unsuccessful, as I did not know by what outward signs their habitations could be distinguished, and the extent of mud-bank left bare by the retreating tide, was, as compared with my powers of delving, practically limitless.

At last, toward evening, while digging in the bend of a small creek, in a stratum of soft, bluish mud, and at a depth of about a foot below a small puddle, I found five small fishes, which at first I believed to belong to an undescribed species, so little did they resemble the typical *G. mirabilis*, but which proved, upon a closer examination, to be the young of that species. There was the depressed, broad head, the funnel-shaped ventral "disk" formed by the union of the two ventral fins, and the compressed tail of the long-jawed goby, but where were the long jaws? The jaws were, of course, in their usual place, but their prolongations had only just commenced to grow along the sides of the head, and were not noticeable unless looked for. A comparison of the various specimens proved conclusively that the strange-looking appendage is developed during the growth of the fish, as will be seen by the following measurements of four individuals: —

	No. 1.	No 2.	No. 3.	No. 4.
Total length	65 mm.	98 mm.	132 mm.	165 mm.
From tip of snout to end of maxillary expansion, measured along curve to centre line of jaw.	11 mm.	20 mm.	40 mm.	56 mm.

In the smallest specimen the maxillary expansion extends beyond the orbit for a distance about equal to that which inter-

venes between the anterior margin of the orbit and the tip of the snout; in No. 2 it reaches to the posterior margin of the preoperculum; in No. 3 it ends level with the gill-opening; while in the largest individual it passes the origin of the pectoral and ventral fins.

What can be the use of this long fold of skin and cartilage, which is not attached to the head except where it joins the mouth; and which from its gradual development and ultimate large dimensions, must certainly serve some useful purpose?

Do not understand that I mean that every part of a creature is of use to it in its present mode of life, for as all naturalists know, there are in structural anatomy, just as in social life, cases of *survival;* remains of organs which were at some former time more developed, parallel in their nature to such survivals in costume, as the two buttons on the back of a man's coat, once useful for the attachment of a sword-belt. But in this fish we have no case of survival, but one of unusual development; the family (Gobiidæ) to which it belongs presents no similar case, although its members have somewhat similar habits, and the conviction grows upon us, as we consider the subject, that the long jaws serve some useful purpose in the economy of the creature. In view of the half-terrestrial life led by this fish, I am inclined to suspect that the expansion of the upper jaw may serve for the retention of a small quantity of water, which, slowly trickling downward into the mouth and gills, keeps the latter moist when, from an unusually low tide or a dry season, the waters of its native creek fail, perhaps for several hours, to reach the holes in which the fishes dwell. It may be objected to this view that, were such an appendage necessary, or even useful, other species of Gobiidæ, whose habits are similar, would show traces of a similar adaptation. This, however, by no means follows. Nature has many ways of working out the same end; and it must be remembered that every real species when thoroughly known differs somewhat in habits from its congeners, or at least from its family friends. To take an illustration from the mammalia. The chimpanzee and the spider-monkey are both quadrumanous and both arboreal, yet the end which is attained in the former by its more perfect hands is reached in the latter by its prehensile tail.

There are many fishes which can resist a tolerably long desiccation, but the means by which they are enabled to do this vary greatly. The Ophiocephalidæ, a small family of fresh-water fishes found in the East Indies, have a cavity capable of contain-

ing water situated inside the head, and accessory to the gill-cavity; the *Labyrinthici*, of which the *Anabas scandens*, or climbing perch, is a well-known example, have an organ composed of thin laminæ, and well suited to contain water, situated in a cavity over the gills, and the gill-opening is narrow; the cuchia (*Amphipurus cuchia*) of Bengal is provided with a sac for the reception of air, and has rudimentary branchiæ, while the three curious fishes forming the sub-class Dipnoi, the Protopterus of West Africa, the Lepidosiren of the Amazon and its tributaries, and the Ceratodus of the rivers of Queensland, Australia, are all provided with a lung-like air-bladder, and have narrow gill-openings and fewer gills than ordinary fishes.

All the fishes mentioned above can bear deprivation of water for more or less time; the Ophiocephalidæ and the cuchia take overland journeys in search of water; the Labyrinthici take some of their prey out of water, are said to be able to ascend trees, and can live for some time in dried mud; and the Protopterus remains alive for many months encased in lumps of the dried mud of the river bed, awaiting only the rainy season to resume its predatory life.

Why may not the extremely long channel formed by the jaw of this rather abnormal member of the goby family be another mode of provision for the requirements of respiration?

The two ordinary gobies (*Gobius lepidus* and *G. Newberryi*), which are found in San Francisco water, although they reside in cavities in the mud or sand, need no such protection as the Gillichthys, since the latter inhabits the tidal sand and mud flats of the sea beach, at such a depth below the surface that it can never be short of water while uncovered by the tide; while the former has not, within my knowledge at least, been found in localities left bare by the tides.

Of the geographical range of the long-jawed goby, to the north of San Francisco, I know nothing, but it extends southward at least as far as the Gulf of California, since I found a single young specimen of it among miscellanea collected there by Mr. W. J. Fisher.

This individual differs from those obtained in the bay of San Francisco in the decidedly reddish tint of the under surface (a slaty gray is the usual color), but this is probably at most only a local peculiarity, as I can detect no other difference.

THE MUSEUM MITE.

BY ANDREW MURRAY.[1]

THE *Tyroglyphus entomophagus* is the smallest of all the known species of this genus. It is remarkable for the parallelism of the sides, and cylindrical appearance of the body, and for its narrowness, especially in the female. Its legs are shorter than in the other species.

It is a species only too well known to entomologists. It takes up its abode in entomological collections, in the interior of the body, or on the surface of the insects, and in the dust which gathers at the bottom of the drawers or boxes. Large insects, with the body full of fatty particles, those which have been brought up in captivity, and which have not paired, and those which have *become greasy* (to use the technical expression), are the most liable to attack. Certain families of Coleoptera, the large *Scarabœidæ*, like *Oryctes* and *Geotrupes*, the *Lucanidæ*, the *Carabidæ*, the *Dytiscidæ*, and the *Hydrophilidæ*, the *Cerambycidæ*, the large or badly dried *Blaptidæ*, may often be seen covered on the surface with excrement and eggs, under the form of white dots, and sometimes contain a considerable number of these Tyroglyphi in the interior of the body.

The body of the large, especially the nocturnal Lepidoptera, the Cicadæ amongst the Hemiptera, the Earwigs, etc., have them likewise, and the quantity sometimes furnished by such insects, where the mites have once obtained a footing, is truly enormous.

The *Tyroglyphus entomophagus* may be found running upon the back of dead insects, and may be seen without the aid of the microscope. According to M. Perris it gnaws the down and the hairs of the insects attacked. It is, however, chiefly in the inside of their body that it lives; it gnaws and dilacerates all substances that are soft or deprived of chitine; hence they are specially destructive to Lepidopterous insects. In handling insects that have been attacked by these Tyroglyphi, we are apt to cause the articulated pieces of which the ligaments have been destroyed to fall asunder, and then there issues from the body a friable matter in which the living Acari swarm.

The friable matter which falls out, when the body of insects gnawed by the *Tyroglyphus entomophagus* is shaken, is composed first, of the excrement of these animals in the form of little round-

[1] Extracted from Economic Entomology: Aptera. By Andrew Murray. London, 1877.

ish grayish masses; secondly, of the eggs in course of development, and of empty shells of hatched eggs, of open and bent shells, cracked often longitudinally; thirdly, of young larvæ and of nymphs, always more numerous than the adult animals; fourthly, of tegumentary envelopes proceeding from the moulting of a great number of larvæ and nymphs; fifthly, of visceral or muscular remains of the body, of pieces of tracheæ, of striated muscular fasciæ, of dried fragments, sometimes of eggs which have not been laid, and which have become loose in the body of the females of the attacked insects.

In the dust at the bottom of the boxes, amongst the remains of all kinds, antennæ, feet, palpi, broken or fallen, one sometimes finds the envelopes of Gamasus, of Glyciphagus, and of Cheyletus Acarids, which live also in collections. Upon the insects themselves, and devouring the excrements and the remains of the Tyroglyphus, M. Perris has found, at Mont-de-Marsan, the larvæ of the *Cecidomyia entomophila.* The walk of the Tyroglyphus entomophagus is slow. It walks with the head bent down, in such a way as to allow the ridge of contact of the two mandibles which go beyond the hairs of the nape of the neck to be seen in front. The males are as numerous as the females, and a little more agile.

It remains to say a few words as to the best means of keeping these mites out of collections, and of getting rid of them when they have once effected an entrance. The insects which are most liable to be attacked by the *Tyroglyphus entomophagus* are, as already said, those which have not been well dried, or which have been placed in ill fitting boxes in a damp room.

When the Tyroglyphus has attacked an insect, one perceives outside little whitish points on the bodies of those with smooth teguments, or on another kind a sort of grayish white powder mingled in the hairs of cottony or downy kinds. Soon under the insect invaded, or on the corresponding sides of the box, one notices a matter of a grayish pulverulent aspect, recalling the efflorescence of saline matters not deliquescent. This dust is said to be quite different from the organic pulverulent debris which results from the ravages of the Anthrenus or Dermestes; these latter produce a fine sawdust, blackish or brownish, but dry and non-adherent. Collections in the south of France, exposed to damp, are very rapidly attacked by Tyroglyphus entomophagus. The mouldiness which shows itself in a collection makes one suspicious of mites, for mould and mites almost always go together.

When an insect is known to be attacked by Tyroglyphus it is best to isolate it in a very dry box. If the insect is glossy the mites which have got into it should be removed with a fine camel-hair brush. If the insect is scarcely attacked, it can be replaced on condition of being watched. But very often one sees reappearing on the body of an insect which has been simply cleaned or brushed, new Tyroglyphi which come from within or from the cavities of the joints where they are apt to gather in large numbers. This shows that the cleansing has been insufficient. One can then have recourse to the heat of the stove or oven. This proceeding is inconvenient when the insect turns out to be what is technically called "greasy." Besides, although the Tyroglyphi may not resist the effect of a high temperature, the eggs often do, especially when they are situated in the interior of the body, and the mites swarm again soon after.

We can scarcely recommend pure water, for if the outside of the dirty insects is washed, it penetrates into the inside, leaving a humidity unfavorable to the object in view.

Alcohol is good for all the insects which can stand its action without being hurt in their colors, hairs, or scales. It will not do for Lepidoptera, but we have often placed beetles that are hard and polished in a flask with a large mouth without taking the trouble of cleaning them. The pin holding the insect is stuck into the under side of the cork, and the body soaks in alcohol without going to the bottom of the vessel. An immersion of several hours or a day is sufficient. Either simple alcohol, or alcohol containing a small solution of corrosive sublimate, will answer. After a bath of an hour in the latter, the insect should be washed in pure alcohol to carry off the sublimate, which, without this precaution, forms a whitish crust and corrodes the pins. We prefer to use alcohol with arsenic or saturated with strychnine, which, in ridding the insects from the Tyroglyphi, has the advantage of preserving them also against the Anthreni.

Besides alcohol, there are liquids which *scour* the insects perfectly, killing the Acarids and carrying off their favorite aliment. These very useful liquids are ether, benzine, essence of naphtha.

Dr. Leconte has utilized the "atomizer" for thoroughly and imperceptibly besprinkling the insects with such liquids.

MM. Grenier and Aubé devised an apparatus for exposing the insects without removal to the vapors of such chemicals. It is a large necrentôme of tin, with fastenings, made with a trench, to be filled with water, so as to submerge the edge of the cover,

and is well adapted for museums and large collections, where the labor of individual cleaning would be too great. But so far as regards mites this is not necessary if the drawers or boxes only fit moderately closely. Then it will be found sufficient to expose a few crystals of pure naphthaline for an hour or two in the drawers. This is the simplest, easiest, and most effectual of all contrivances to destroy mites.

Where it is necessary to treat the insects in detail, another effective but more troublesome plan is to expose the infected insect to the vapor of liquid ammonia, by placing a morsel of sponge in a paint saucer and moistening it with a few drops of powerful liquid ammonia. The insect is placed on a bit of cork alongside of the sponge, and the whole covered by a tumbler or small bell-glass, so as to keep in the vapor; and in ten minutes or a quarter of an hour the cure is generally complete. Sometimes it must be repeated; but this is rarely necessary.

Insects should never be put away until they have been well dried, and, if necessary, freed from fatty visceral matters. This is particularly necessary for kinds brought up in captivity or full of juice at the moment of their capture.

RECENT LITERATURE.

MURRAY'S ECONOMIC ENTOMOLOGY.[1]—While this work refers at length to such myriopods, spiders and Thysanura as in any way affect man, it is mainly devoted to the mites and ticks, and as such is the only recent and complete manual treating of these important animals which is accessible to the English student. The collections forming the basis of the work are in the Bethnal Green Branch of the South Kensington Museum, and must form a curious department of the museum. This collection is designed for the instruction of the people, and the specimens illustrative of insects injurious to vegetation, or obnoxious to man and the domestic animals, are openly exposed in cases along with colored figures of them, often more or less magnified according to the size of the insect, a practice particularly useful in such minute beings as the mites. Models of injuries done to perishable objects have also been added. It is doubtful, judging by the author's statements, whether there is any other museum either in Europe or America where such a mass of information regarding the habits of troublesome or injurious insects have been spread before the people.

[1] *South Kensington Museum Science Handbooks. Branch Museum, Bethnal Green. Economic Entomology. Aptera.* By ANDREW MURRAY. Prepared at the Request of the Lords of the Committee of Council on Education, and Published for them by Chapman & Hall, 193 Piccadilly, London. 1877. 12mo, pp. 433.

In the case of the mites, not only are European species, but a few of the more prominent North American species are described or referred to, and figures given of them copied from illustrations by American authors.

Not only are the human parasites, as the itch mite, etc., figured, but those infesting our domestic mammals and birds; and the leaf and gall mites and allied forms are noticed at greater or lesser length. As an example of the author's mode of treating his subject, we have reprinted in the preceding pages of this number, an account of a mite which injures dried insects in museums in Europe, and which is undoubtedly the species which occurs under similar circumstances in this country. It appears from Mr. Murray's statements that the flour mite (*Tyroglyphus siro* Linn.) and *Acarus farinæ* or cheese mite, and the milk mite (*Acarus lactis*) are all different names for one and the same species, as is also the *Acarus dysenteriæ* of Linnæus, this mite having in one case caused the dysentery in Rolander, a student of Linnæus. Figures and an interesting account is given of Cross's famous *Acarus*.

The plan of the work is excellent and well carried out, and we sincerely trust that the author will be able, as he designs doing, to furnish us with similar treatises on the "bug, locusts, grasshoppers, cockroaches, and earwigs; the two-winged flies, the bees, wasps, etc.; the dragon-flies and May-flies; butterflies and moths; and lastly, the beetles." These manuals are prepared at the request of the Lords of the Committee of Council on Education, and give evidence of the liberal spirit now pervading the minds of the public men of Great Britain.

BAIRD'S ANNUAL RECORD OF SCIENCE AND INDUSTRY FOR 1876.[1] — This is the sixth volume of the series, and presents a summary of the most important discoveries in natural and physical science during the year 1876. In addition, a large portion of the book is devoted to abstracts, more or less systematically arranged, of special memoirs, while there is appended a necrology, and a list of the more important scientific publications for the year. Such a book needs a detailed index, and a systematic and analytical table of contents, and we doubt if much fault will be found with the manner in which they have been prepared. Professor Baird has been aided by a number of scientists, whose names are given with the departments which they have reported upon, so that the book carries besides the authority of the name of the editor that of the specialists who have assisted him.

As a handbook of scientific progress this series of annual records is not only indispensable to the general reader, but we doubt not that the specialist who would not be ignorant of what has been done in other departments of science than his own, will find these volumes better fitted to satisfy his thirst for general knowledge than any other with which we are acquainted. The plan of the work leaves in its present state little

[1] *Annual Record of Science and Industry for* 1876. Edited by SPENCER F. BAIRD, with the assistance of eminent men of science. New York: Harper & Brothers. 1877. 12mo, pp. 609.

room for criticism, and the execution seems as a general rule quite worthy of the plan.

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A brief Comparison of the Butterfly Faunas of Europe and Eastern North America, with Hints Concerning the Derivation of the Latter. By S. H. Scudder. (From the Proceedings of the American Association for the Advancement of Science. Aug., 1876.) Salem, June, 1877. 8vo, pp. 6.

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On the Inhabitants of the Admiralty Islands, etc. By H. N. Moseley. (Reprinted from the Journal of the Anthropological Institute. May, 1877.) 8vo, pp. 52, 4 plates.

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Principal Characters of the Coryphodontidæ. Characters of the Odontornithes, with Notice of a New Allied Genus. Notice of a New and Gigantic Dinosaur. By O. C. Marsh. (From the American Journal of Science and Arts, xiv. July, 1877.) 8vo, pp. 8, 2 plates.

Zur Entwickelungsgeschichte der Dekapoden. Von Paul Mayer. (Abdruck aus der Jenaische Zeitschrift, für Naturwissenschaft, Bd. xi.) 8vo, pp. 81, 3 plates.

On the California Species of Fusus. 8vo, pp. 5. Preliminary Descriptions of New Species of Mollusks from the Northwest Coast of America. 8vo, pp. 6. By W. H. Dall. (From the Proceedings of the California Academy of Science, March 19, 1877.)

On the Brain of Procamelus occidentalis. By E. D. Cope. (From the Proceedings of the American Philosophical Society.) Published June 15, 1877. 8vo, pp. 52, with a plate.

On the Vertebrata of the Bone Bed in Eastern Illinois. By E. D. Cope. (From the Proceedings of the American Philosopical Society.) Published June 20, 1877. 8vo, pp. 11.

Ueber den Ursprung der Blumen. Von Dr. Hermann Müller. (Aus Kosmos.) 1877. 8vo, pp. 14.

Ueber Bau und Entwickelung des Stachels der Ameisen. Von Dr. H. Dewitz. (Siebold und Kölliker's Zeitschrift, xxviii.)

The Tailed Amphibians, including the Cæcilians. A Thesis: Presented to the Faculty of Michigan University. By W. H. Smith. Detroit. 1877. 12mo, pp. 158.

Tribes of the Extreme Northwest. By W. H. Dall. (Department of the Interior. U. S. Geographical and Geological Survey of the Rocky Mountain Region. J. W. Powell, Geologist in Charge. Part 1.) 1877. 4vo, pp. 106, with a map.

History of the American Bison, Bison Americanus. By J. A. Allen. (Extracted from the Ninth Annual Report of the U. S. Geological Survey. F. V. Hayden in charge.) Washington. 1877. 8vo, pp. 587.

Ethnography and Philology of the Hidatsa Indians. By Washington Matthews. (Miscellaneous Publications, No. 7, U. S. Geological and Geographical Survey. F. V. Hayden in charge.) Washington. 1877.

GENERAL NOTES.

BOTANY.[1]

ILLUSTRATIONS OF NORTH AMERICAN FERNS. — It gives us sincere pleasure to learn that it is proposed by Mr. S. E. Cassino to publish an illustrated popular work on our ferns. The announcement is made that the drawings will be from sketches by Mr. J. H. Emerton, and that the text will be furnished by Professor Eaton. The latter is a recognized authority thoroughly familiar with American ferns; Mr. Emerton's skill as a draughtsman is well known to our readers. The plates are to be in color, and the work is promised at an exceedingly low price.

ACER DASYCARPUM. In 1843, Mr. Emerson measured a tree of this species, growing in the town of Stockbridge, Mass., when at three feet from the ground, it girted twelve feet. In October, 1876, the same tree was measured by Mr W. R. Robeson, who reports that its circumference at the same height, was then fifteen feet and nine inches, showing an annual average increase of circumference during the last thirty-three years of a little over 1.36 inches. — C. S. SARGENT.

[1] Conducted by PROF. G. L. GOODALE.

OBSERVATIONS ON SILPHIUM LACINIATUM, THE SO-CALLED COMPASS PLANT.[1] — For the past six or eight years there has been little doubt of the curious polarity of the root and stem-leaves of the large coarse plant known throughout the prairie regions by the name of the compass plant. It appears, however, that few accurate measurements of the bearings of these leaves have been made. So that while they are now considered as pointing more or less to the north, but little is known as to how nearly they arrange themselves upon the meridian. In order to contribute to a better knowledge of this matter, I have for several years been making observations, the results of which I herewith transmit: —

TABLE I.

Bearings of the leaves of fourteen small plants, many of which had but one leaf each: —

North	1°	30′	East.	North	4°	30′	West.
"	1°	45′	"	"	7°	30′	"
"	1°	45′	"	"	8°	30′	"
"	5°	30′	"	"	9°	15′	"
"	6°	0′	"	"	13°	30′	"
"	6°	30′	"	"	22°	15′	"
"	8°	0′	"	"	25°	0′	"
"	21°	30′	"	"	29°	30′	"
"	82°	30′	"	"	34°	0′	"
				"	34°	0′	"
				"	37°	0′	"
				"	61°	45′	"
				"	71°	45′	"

Fifty per cent., it will be observed, deviated less than ten degrees, and eighty-six per cent. less than forty-five degrees, from the meridian.

TABLE II.

Bearings of thirteen leaves, all of which grew on one large plant: —

North	0°	30′	East.	North	0°	30′	West.
"	0°	45′	"	"	1°	15′	"
"	3°	30′	"	"	35°	30′	"
"	3°	45′	"	"	88°	0′	"
"	3°	45′	"				
"	10°	30′	"				
"	17°	30′	"				
"	36°	0′	"				
"	89°	30′	"				

Fifty-four per cent. of these leaves deviated less than four degrees from the meridian, and eighty-five per cent. less than forty-five degrees.

TABLE III.

Bearings of the leaves of a medium sized plant: —

North	1°	0′	East.	North	0°	15′	West.
"	1°	30′	"	"	0°	30′	"
				"	0°	30′	"
				"	20°	0′	"
				"	56°	0′	"

[1] See an article on this subject in THE AMERICAN NATURALIST for March, 1871, where may be found also references to other papers. An article appeared some years since in the American Agriculturist, and another recently in Nature, in which good cuts of the compass plant were given.

Of these seventy-one per cent. deviated less than two degrees, and eighty-five per cent. less than forty-five degrees from the meridian.

TABLE IV.

Bearings of the leaves of a large plant: —

North 0° 0′ East.	North 17° 0′ West.
“ 2° 30′ “	“ 32° 0′ “
“ 3° 0′ “	“ 35° 0′ “
“ 11° 0′ “	
“ 13° 0′ “	
“ 16° 15′ “	
“ 40° 15′ “	

It will be observed that, with a good deal of variation in the bearings, none of the leaves diverge as far from the meridian as forty-five degrees.

TABLE V.

Bearings of the leaves of another large plant: —

North 5° 0′ East.	North 2° 30′ West.
“ 9° 30′ “	“ 3° 45′ “
“ 12° 45′ “	“ 4° 45′ “
“ 14° 30′ “	“ 23° 30′ “
“ 14° 30′ “	“ 45° 30′ “
“ 20° 30′ “	
“ 21° 0′ “	
“ 28° 30′ “	
“ 29° 30′ “	
“ 31° 45′ “	

Thirty-three per cent. deviated less than ten degrees, and ninety-three per cent. less than forty-five degrees from the meridian.

TABLE VI.

Bearings of the leaves of ten plants, large and small: —

North 1° 45′ East.	North 6° 30′ West.
“ 1° 45′ “	“ 7° 45′ “
“ 3° 30′ “	“ 12° 15′ “
“ 4° 15′ “	“ 13° 30′ “
“ 6° 45′ “	“ 21° 20′ “
“ 7° 0′ “	“ 23° 30′ “
“ 7° 45′ “	“ 30° 0′ “
“ 12° 45′ “	“ 33° 30′ “
“ 16° 0′ “	“ 43° 0′ “
“ 18° 45′ “	
“ 37° 45′ “	
“ 39° 0′ “	
“ 41° 15′ “	
“ 42° 15′ “	
“ 42° 30′ “	
“ 46° 0′ “	
“ 52° 15′ “	

Thirty-four and one half per cent. of these leaves deviated less than ten degrees from the meridian, and ninety-two per cent. less than forty-five degrees.

Taking the bearings of all the leaves observed (ninety-three in all), we find that about thirty per cent. did not vary more than five degrees, forty-two per cent. not more than ten degrees, and ninety per cent. not more than forty-five degrees from the meridian.

If now we tabulate the bearings so as to indicate how many lie between 0 and 5° east, between 5° and 10° east, and so on, we have —

TABLE VII.

From	0 to 5°	East,	18	leaves.				From	0 to 5°	West,	9	leaves.
"	5° to 10°	"	8	"				"	5° to 10°	"	5	"
"	10° to 15°	"	7	"				"	10° to 15°	"	3	"
"	15° to 20°	"	4	"				"	15° to 20°	"	2	"
"	20° to 25°	"	3	"				"	20° to 25°	"	5	"
"	25° to 30°	"	2	"				"	25° to 30°	"	2	"
"	30° to 35°	"	1	"				"	30° to 35°	"	5	"
"	35° to 40°	"	3	"				"	35° to 40°	"	2	"
"	40° to 45°	"	4	"				"	40° to 45°	"	1	"
"	45° to 50°	"	1	"				"	45° to 50°	"	1	"
"	50° to 55°	"	1	"				"	50° to 55°	"	0	"
"	55° to 60°	"	0	"				"	55° to 60°	"	1	"
"	60° to 65°	"	0	"				"	60° to 65°	"	1	"
"	65° to 70°	"	0	"				"	65° to 70°	"	0	"
"	70° to 75°	"	0	"				"	70° to 75°	"	1	"
"	75° to 80°	"	0	"				"	75° to 80°	"	0	"
"	80° to 85°	"	1	"				"	80° to 85°	"	0	"
"	85° to 90°	"	1	"				"	85° to 90°	"	1	"
	Total leaves East, 54.								Total leaves West, 39.			

In one case (Table VI. in part) of twenty-eight leaves examined, all but three had rotated upon their petioles in assuming their positions, that is, they *twisted* their petioles; of these twenty rotated with the sun, and five against it. Of the three remaining leaves, two rotated their two half blades upon their midribs, so that *both edges* tended to point towards the north; the remaining leaf did not show any evidence of rotation in either direction, and its bearing was seven degrees east of north.

In another case (the second leaf in Table I.) a leaf was found to have rotated through at least 270° of arc to reach its final position. Originally it stood with one edge nearly due east, and the other west; the western edge then rotated northward, passed the zero point and swung away round to the south, passing 1°45′ beyond that point. This rotation was all confined to the petiole.

How to account for this evident turning has been, and still is a puzzling thing. In order to see whether there was any diurnal rotation, or turning, such as is observed in the sunflower, I carefully set stakes in line with several leaves having quite different bearings, and watched them closely for about a week, but failed to discover the least tendency to any such motion.

Dr. Gray, I believe, first made the suggestion that the structure of the leaf must have something to do with their so-called "polarity," and made some examinations as to the number of stomata upon the two surfaces. I have made many examinations by the aid of the microscope, and have determined that in the central part of a full grown leaf the stomata are at the rate of 52,700 to each square inch of upper surface, and 56,300 to each square inch of lower surface. In this calculation I made no account of the veins, which apparently occupy an equal area on both surfaces. They probably take up fully one half the surface, and they are destitute of stomata.

Five years ago I examined the two surfaces of quite young leaves,

and after many observations found that the relative numbers were as ninety stomata to the upper, and eighty-seven to the lower surface. A year later the average of three observations on older leaves gave as the relative numbers, sixty-two for the upper, and sixty-nine for the lower surface. Again, in 1874, averages of carefully made observations upon young leaves gave as relative numbers forty-nine for the upper surface, and fifty-nine for the lower. Observations made at the same time upon old leaves gave the numbers fifty-seven for the upper, and seventy-five for the lower surface.

Now by comparing these results with the number of stomata in the leaves of other plants, we arrive at the value of the greater or less abundance of these on either surface as influencing the direction of the leaves. In 1872 I examined the leaves of the common sunflower (*Helianthus annuus*, var.) and found that the stomata of the upper surface were to those of the lower as 102 to 105. In 1874 I found after repeated observations that the stomata on a cabbage leaf were as seventy for the upper surface to eighty-six for the lower.[1] Now these numbers are so nearly like those found in *Silphium*, that we conclude that the mere number of stomata can have little if anything to do with determining polarity, for in both of these cases there is an utter want of it. I think we may then with reasonable safety throw the stomata out of the question for it is *very doubtful if they alone* have anything to do with it. The texture of the leaf must be more carefully examined than it has yet been to enable us to determine the real cause of the polarity. We know that some leaf surfaces, generally the upper — turn quickly and forcibly towards the sun, as is notably the case in the sunflower mentioned above; the cause of this heliotropism we do not know: now if we conceive a leaf with its two surfaces endowed with this sensitiveness to light, or, in other words, if both sides are equally heliotropic, the leaf will, in the struggle of the two sides for the greater share of light, be compelled to assume a position similar to that taken by the leaves of *Silphium laciniatum*; but here we need further facts. — C. E. Bessey, Ames, Iowa.

Precocity of Blossoming in the Orange. — In general it takes the orange tree, in the most favorable localities in Florida, at least five years from the sowing of the seed to produce the flowers and fruit, and

[1] Adolph Weiss records in Jahrb. für witsen. Bot. volume iv. 1865, that he found the stomata to exist in the following proportions upon the two surfaces, namely: —

Helianthus annuus, upper surface 175, under surface 325.
Brassica oleracea, " " 219, " " 301.

Which differ considerably from my proportions. However, some of his other plants are almost equally good examples for my purpose, as —

Datura stramonium, upper surface 114, under surface 189.
Chenopodium ambrosioides, " " 184, " " 156.

Morren, in Bull. de l' Academie Royale de Belgique, gives the following proportions, namely: —

Trifolium pratense, upper surface 207, under surface 335.
Helianthus annuus, " " 137, " " 242.

often this time is extended to ten years. This year, however, all over the State, numerous instances have occurred in which seedling oranges of not as many months old produced blossoms — the baby trees varying in height from one and a half to six inches. Several of these have been exhibited in Jacksonville. Of about one hundred oranges which had come up from seed planted by Judge Hayden in December, 1876, seven had a perfect flower at the top, in the following April, and when they were only an inch and a half high. These remarkable instances of premature blossoming are, I think, worthy of being recorded. — HENRY GILLMAN, Waldo, Florida.

PLANTS OF BRAZIL AND GERMANY. — Fritz Müller gives in *Flora*, an interesting account of a recent journey to the highlands of his Province, St. Catharina, and the head waters of the river Uruguay. He found many plants which reminded him, by their *facies*, of the plants of Germany. The violets, especially, were very near those of Germany. He observes that the minuter flowers of a white violet are not only cleistogamic, but are developed *under* the soil. It may be remembered that some of our Eastern species, notably V. sagittata, have late inconspicuous flowers which are very fertile. So far as we are aware, these late flowers of our violets are above and not under ground. Müller had not noticed in the lowlands any seeds or fruits which bury themselves in the ground, but on the higher plain he observed many which have marked hygroscopic properties by which they can bore their way into the soil.

CELTIS OCCIDENTALIS. — A very old specimen of this tree is growing in an exposed situation close to the shore near the Squantum Beach Hotel in the town of Quincy, Mass. Its size is worthy of record. At the ground it has a circumference of eleven feet and four inches, and at five feet from the ground, just where its short stem is the smallest, it girts seven feet. A still finer specimen stands in the city of Lowell, and this at four feet from the ground girts seven feet six inches. This is the tree of which a photograph appears in Emerson's Trees and Shrubs of Massachusetts, second edition, where it is called *Celtis crassifolia*, although in foliage and fruit it is identical with the form of *C. occidentalis* common in the Eastern States.

BOTANICAL PAPERS IN RECENT PERIODICALS. — *Bulletin of the Torrey Botanical Club.* May and June. Notes on the Botanical Geography of Syria. (An interesting account of the seven botanical regions into which Syria is divided, namely: (1.) The dunes, or hills of drifting sand. (2.) The littoral plain. (3.) The median mountain region. (4.) High Lebanon and Hermon. (5.) The high lake-bed. (6.) Valley of the Jordan and the Dead Sea. (7.) The desert.) Mr. Miller sends notes of Suffolk County notes. C. F. Austin, New Hepaticæ.

Botanical Gazette. Professor Porter gives in the July number an interesting account of some variations in mandrake, or may apple, *Podophyllum peltatum*, and Mr. Shriver has a few notes on *Nepeta* and *Draba.*

Trimen's Journal of Botany. June. W. G. Smith, A new species of *Xerotus X. sanguineus.* J. G. Baker, New Ferns from the Andes of Quito. A. W. Bennett, Review of the British species of *Polygala.* E. M. Holmes, The Cryptogamic Flora of Kent. Several extracts and excellent abstracts, together with a notice of the Botanical Garden at Copenhagen, and the titles of articles in botanical journals close the number.

Flora, No. 13. Dr. George Winter, Lichenological notices (continued in No. 14). F. v. Thümen, Notes on "Mycotheca Universalis." No. 14. Emil Godlewski. Is the product of assimilation in Musaceæ (the Banana tribe) oil or starch? (Answer, "Everything shows that the product of assimilation in the species of *Musa* and *Strelitzia* is not oil, as Briosi states, but starch, just as in other plants.") Nylander. Additions to European Lichenography (continued in No. 15). No. 15. M. Gandoger, New Roses in South Eastern France, Fritz Müller, a Letter from Brazil (noticed elsewhere).

Botanische Zeitung, No. 21. G. Kraus, The Occurrence of Inulin in other plants than Compositæ. (The writer has detected Inulin in the allied orders Campanulaceæ and Lobeliaceæ [which, by the way, have been united as tribes under one order by Bentham and Hooker], in Goodeniaceæ and Stylideæ.) No. 22. Dr. Brefeld, On the Entomophthoræ (an order of Fungi) and their allies (continued in 23). No. 23, Dr. G. Haberlandt, On the Origin of Chlorophyll Granules in the Germ-Leaves of *Phaseolus vulgaris.* No. 24, conclusion of the preceding article by Haberlandt. "I believe that I have now shown that *true* chlorophyll granules can arise, as v. Mohl pointed out, by the enveloping of starch granules with colored protoplasma." No. 25, Professor Schenk, On the Relations of Structure of Fossil Plants. Reports of Societies.

ZOÖLOGY.[1]

THE BRANCHIÆ OF THE EMBRYO PIPA. — In *Nature* for April 5, 1877, is an interesting article, author not stated, upon The Development of Batrachians without Metamorphosis. On page 492 occurs the following passage: "The young of *Pipa Americana* [the Surinam toad] come forth from the eggs laid in the cells on their mother's back, tailless and perfectly developed. In them, likewise, no one has yet detected branchiæ." Two points here made are not in accordance with the observations of the late Prof. Jeffries Wyman, as recorded in the *American Journal of Science and Arts,* 1854, second series, vol. xvii. pp. 369–374.

Wyman states that the eggs are transferred by the male to the back of the female, which presents "a uniform surface throughout;" "their presence excites increased activity in the skin, it thickens, and is gradually built up around each egg, which it at length incloses in a well-defined pouch."

[1] The departments of Ornithology and Mammalogy are conducted by Dr. ELLIOTT COUES, U. S. A.

On pages 370 and 371 he figures and describes the earlier embryos as having "three branchial appendages on each side of the head. In a later stage the external branchiæ had disappeared, but a small branchial fissure was detected on each side of the neck, and within this on each side a series of fringed branchial arches."

Wyman's figures are evidently enlarged, and he gives no measurements of the embryos. But his figures and descriptions are explicit, and I am not aware that any statement by him has ever been found to be incorrect.

In view, however, of the passage above quoted from *Nature* I have endeavored to obtain confirmation of Wyman's statement. On examining two embryos from cells upon a Pipa presented to me by Dr. J. B. S. Jackson, I found them very ill preserved. They measured fourteen mm. from tip to tip, and I could find no trace of branchiæ internal or external. I then suggested to Dr. Jackson an examination of some better-preserved examples in the Warren Anatomical Museum of the Medical College of Harvard University. The examination was made by Mr. C. S. Minot, who reports as follows: —

"I have examined two eggs from the back of the Pipa, and found the embryos a little more advanced than that figured by Professor Wyman; they are between twelve and thirteen mm. in length. The gills were partly absorbed, but a single slit with the gills still projecting could be readily seen on each side at the back of the head. I could not make a more detailed examination, as the eggs were not well enough preserved."

We may conclude, then, pending the extended examination of a series of perfectly preserved embryos, that the Pipa does possess external branchiæ at a certain period before hatching. — BURT G. WILDER.

MAMMALS NEW TO THE UNITED STATES FAUNA. — I am desired by Dr. J. C. Merrill, U. S. A., to record the capture by him at Fort Brown, Texas, of two species of Mammals not previously found in the United States. One of these is the *Felis yaguarundi*, and the other is a species of *Nasua*.

Felis yaguarundi was introduced into our fauna in 1857, by Professor Baird, in his Mammals of North America, his material consisting of a skull collected by Dr. Berlandier at Matamoras, Mexico. It was then first recognized as an inhabitant of the valley of the Lower Rio Grande, but it is only now actually taken in United States territory. It is described as larger than the common house-cat, and more elongated in all its proportions, with the tail as long as the body exclusive of the head, and the prevailing color a continuous grizzled brownish-gray without any spots. An extended account is given in the Mexican Boundary Report, vol. ii. pt. ii., page 12 (1859). The skin which Dr. Merrill has transmitted to the Smithsonian was obtained from a Mexican who shot the animal a few miles from Fort Brown, Texas. "Last summer," writes Dr.

Merrill, "while duck shooting at a lagoon about six miles from the fort, I saw one of these cats come out of some thick chaparral and run across an open resaca, within seventy-five yards of me. The long tail and gray color were distinctly seen and unmistakable."

The occurrence of the *Nasua* is particularly interesting, as it adds not only a species but a genus and family of mammals to our fauna. Dr. Merrill kept the coati some time in confinement, but finally killed it, and transmitted the specimen to the Smithsonian. It is unfortunately not in very good order, having been attacked by insects, but will answer for identification. It is probably the species referred to on page 22 of the Mexican Boundary Report as "*Nasua fusca*," under which name the Berlandier MS. speaks of a coati as common in Tamaulipas. Dr. Merrill took the following description from the living animal: —

Female. Nose to base of tail, about twenty-two inches; tail vertebræ, twenty; tail with hairs, twenty-one. General color, grayish yellow, the hairs lighter at the ends; shoulders and other parts yellowish-white; tail brownish-yellow, darker towards the tip, in form very thick at the base and gradually tapering; feet black, five-toed, claws long; ears small and rounded; snout long, slender and flexible, extending one and one half inches beyond upper incisors; top of head yellowish; three white spots, one above, another beneath, and a third three fourths of an inch behind, the eye; terminal inch and a half of snout with whitish hairs; rest of face brownish; nose black. She is quite tame, is a great mouser, and makes a very amusing pet." — ELLIOTT COUES, Washington, D. C.

SPONTANEOUS ADAPTATION OF COLOR IN THE LIZARD. — The lizards are of great beauty and variety in Florida, and are generally not easily alarmed, and so tame as to afford good opportunity for observing their characters and habits. Their having the capacity of, chameleon-like, changing color, has, I believe, been questioned. Since my residence here, I have had ample means of determining the point, and can positively state that they possess the power to which I have reference in a remarkable degree; indeed I was unprepared for the extreme development of this curious gift, which they spontaneously exhibit. For instance, I have seen a small yellowish-brown lizard, on quitting the ground, instantly assume the dull gray hue of the weather-beaten fence-rail it glided upon and along. Passing under some olive-tinted foliage, it would next adopt that color, to be succeeded by a full bright green of emerald-like glow, as it reached and rested underneath the sprays of grass and other leaves of corresponding shade. The original yellowish-brown color would again be assumed on the lizard returning to the ground. Each of the changes mentioned appeared to be almost instantaneous, and the entire series could not have occupied much more than one quarter of a minute of time.

At Santa Fé Lake, in Alachua County, these interesting little creatures are uncommonly abundant. They frequently enter dwellings, bask-

ing on the window-sill or gliding like a sunbeam along the back of a chair; and some are so tame that they permit themselves to be stroked with a straw. — HENRY GILLMAN, Waldo, Florida.

SUPPOSED DEVELOPMENT OF PICKEREL WITHOUT FECUNDATION. — March 15, 1875. The boys brought in some brook pickerel. One was swollen with spawn, weight of fish 521 grains; of spawn freed from membrane, 127 grains, 117 spawn weighed 5 grains. Therefore whole number about 2972.

This spawn was amber colored, and the eggs were in general translucent. Occasionally an egg could be seen which was slightly smaller than the rest, and clouded, and some few were opaque. These eggs, thus marked, presented different appearances under the microscope. I have mislaid the notes and drawings that I took at the time, but can furnish the following facts from memory. The clouded eggs showed a different development from the others, there being a greater difference in size of the cells, and occasionally the cells arranged in lines. Some of the opaque eggs had evidently developed in the line of the fecundated egg, as the cells were arranged in the form of a curled fish, the line of the back being well defined, the line of the belly and sac poorly or not at all defined, while there was a concentration of cells about the locality of the eye. I cannot say that I saw a young fish, for I did not, but I saw what I considered sufficient to interpret as development to a certain degree, without fecundation.

I was so much surprised, that for a time I doubted my own eyesight, and called my brother to look. He saw what he called a young fish in the egg, and so I was convinced, but I had not the courage to send my observations to men of science.

This next spring I will try and procure some fresh specimens, and if my observations can be verified, as I doubt not but that they can be, I will send them to you.

I should not consider this memorandum worthy of being forwarded to you, were it not for the encouragement of your letter, and I am fully as aware that such incompleteness can be of little value to science. Yet I am somewhat familiar with the microscope, and have studied the ovary of young calves, both in a fresh and injected state, and have had sufficient experience to eliminate imagination from my results, and recognize facts. I therefore have confidence that I saw what I have so imperfectly outlined, and I hesitate to ask others to believe, on account of their wonderful nature, that there can be such a development without fecundation in a vertebrate. — E. LEWIS STURTEVANT, South Framingham, Mass., July 8, 1877. (Communicated by the Smithsonian Institution.)

ANTHROPOLOGY.

THE CLASSIFICATION OF STONE IMPLEMENTS.—The kindly criticism of my descriptions of the Indian relics found in New Jersey, in the Smithsonian Annual Report for 1875, by O. T. M., wherein he remarks that the writer has shown too great a fondness for classifying the various forms met with, suggests the propriety of offering a few remarks on the absolute necessity of field-work, in correctly pursuing archæological study, at the same time without intending to intimate that my lenient critic is not competent to pass judgment; for certainly it cannot be said of the Smithsonian collections which he has studied that they have been ignorantly gathered, but archæological specimens of themselves, purchased of dealers or picked up by others than students of the subject, are in a great measure valueless as helps to unravel any ethnological puzzle. I cannot conceive of a position in which one is more liable to fall into errors than in judging of the uses of stone implements from their shapes only. It cannot, in fact, be shown that the same pattern might not have had a far different use on the Atlantic coast from the present use of such a form in the far West. The "leaf-shaped arrowheads" are stated to be used only as knives in Colorado and Utah, but were doubtless also arrowheads in New Jersey. It must be remembered, too, that the varieties of stone implements are by no means endless. Rather their limited range of forms renders it obvious that the surroundings of a sea-coast tribe necessitate a different use for many of the simpler shapes than that of such tribes as occupied a mountainous region. The varieties of game, the pursuit of a primitive agriculture, and a hill-tribe's general surroundings suggest at once uses for characteristic forms found there that would not be true of like forms found along the coast. This brings me to my subject proper, which is to insist that our *safest* guide in studying the relics of a locality long since deserted by its aboriginal occupants is the circumstances surrounding the discovery of every specimen found. To accomplish this an archæologist must be his own collector. Fully convinced of this, I have personally gathered several thousands of relics from a tract of about one thousand acres, and have by no means exhausted the supply; and this laborious field-work resulted in the conviction that such and such a form was for this or that purpose, as a rule. As an illustration, let me instance those long, slender, tapering spears, which I have called "fishing spears." The conclusion that they were used solely (?) for such a purpose was based on the fact that they are essentially (that is, in this locality) a "water find." From the Delaware River, and especially from the deep mud of Crosswick's Creek, I have dredged numbers of this pattern; and when found on the surface I believe they have always been very near the larger creeks and the river.

This association, coupled with the shape of the specimens, which is one admirably adapted to spearing fish, I submit, quite naturally suggests

such a use of this particular variety; but the precise range of use of any one form of stone implement can scarcely be brought down to a mathematical demonstration. I cannot go further into detail, but will add that as in the case of fishing spears, so with many other forms, of which, perhaps, I have spoken too confidently; but I still submit that the field rather than the cabinet is the proper place to study stone implements.

With reference to the division of the Stone age in New Jersey into an older and a later stage, I will but say that what I deem a conclusive demonstration of the correctness of this opinion will shortly be published in considerable detail, and until then on this most important point will gladly "rest our case." — CHARLES C. ABBOTT.

ANTHROPOLOGICAL NEWS. — In *Nature* for April 5, 1877, is a full report of a lecture delivered at the Royal Institution, London, by Francis Galton. The object was to show how individuals of different generations resemble each other so closely, while individuals do not necessarily tend to leave their like behind them, especially if they depart from the average; yet, on the whole, the proportion of gradation of long and short, strong and feeble, and dark and pale appears to be constant. The author displays his accustomed ingenuity in the arrangement of his illustrative diagrams.

The committees on the "historical exhibition of ancient art in all countries, and of the ethnography of peoples foreign to France," to be opened at the Universal Exposition at Paris, in 1878, so far as appointed stand as follows: Adrien de Longperier, director; Gustav Schlumberger, general secretary. A commission of admission and classification, divided into nine sections, is charged with preparing and organizing the exhibit. The following gentlemen will preside over the sections: —

1. Primitive art and antiquity of Gaul, Alexander Bertrand, Jules Desnoyers, the Marquis of Vibraye, Frederic Moreau, Dr. Hamy.

9. Ethnography of peoples outside of France, Alphonse Pinart, J. L. Gerome, Albert Goupil, Dr. Hamy, Henri de Longperier.

Mr. D. B. Perry contributes to the *Saline County News*, published at Crete, Nebraska, an interesting letter on the Pawnees, correcting some mistakes made in Appleton's Cyclopedia, and pays a handsome tribute to Mrs. E. G. Platt, who spent many years among them. It is to be hoped that Mrs. Platt will give some permanency to her knowledge of this rapidly perishing tribe.

Volume iii., No. 1, of Prof. F. V. Hayden's Bulletin is out, and contains the following papers on anthropological matters: —

I. A Calendar of the Dakota Nation, by Bvt. Lt.-Col. Garrick Mallery, U. S. A., with a plate.

II. Researches in the Kjökkenmöddings and Graves of a Former Population of the Coast of Oregon, by Paul Schumacher. Seven plates.

III. Researches in the Kjökkenmöddings of a Former Population of

Santa Barbara Island and the Adjacent Mainland, by Paul Schumacher. Fourteen plates.

IV. The Twana Indians of the Skokomish Reservation, by Rev. M. Eells. Three plates.

The first paper is a very ingenious device of the Dakotas to represent the leading events of a series of years extending from 1800–1871. Of Mr. Schumacher's wonderful discoveries we have often spoken in terms of praise. Mr. Eells' paper is an elaborate set of answers to the pamphlet of directions sent to collectors for the Centennial Exhibition.

Dr. Frederick D. Lente, of Palatka, Fla., contributes to the March and April numbers of the *Semi-Tropical*, published at Jacksonville, two very interesting papers on the mounds of Florida. The doctor deserves great credit for this useful expenditure of his own leisure and for the advice conveyed in his papers concerning the good effect upon the minds and bodies of invalids, to be realized by seeking out-of-door amusement and occupation.

In 1872 M. Kouznetzoff was sent by the Russian government through the Lithuanian provinces to study their ethnography. The result of his labors occupies four volumes and a chart. The Lithuanian language has been encroached upon by the Prussians on the west, the Russians on the northeast, and by the Poles on the south. The study of this ancient branch of Aryan speech is made very interesting by the theory of Omalius, published in 1865, that the Aryan races are of European and not of Asiatic origin.

Dr. José Dionisio Anchorena sends to the Smithsonian Institution a copy of his Gramatica Quechua, o del Idioma del Imperio de los Incas. Lima. 1874.

Professor Huxley, in his lecture at the Kensington Museum, on Saturday, December 16, 1876, defined the boundaries of biology, stating that biologists surrendered all that part of the field which relates especially to the history of man as a social and moral being. Anthropology has been defined as the "biology of man;" but the restriction of the term "biological anthropology" to the application of Professor Huxley's definition to mankind will suit the meaning given to this term by M. Broca in his opening lecture before the Institut d'Anthropologie.

Another periodical, just started in Paris by MM. H. Gaidoz and E. Rolland, attests the growing interest in anthropological matters. It is called *Mélusine, Revue de Mythologie, Littérature Populaire, Traditions, et Usages.* While aiming to collect the myths and folk-lore of France in particular, it will cover the whole field of mythology and legend.

The Rev. Stephen D. Peet, Ashtabula, O., has issued a circular of the Archæological Exchange Club, containing the conditions of membership. The object is to effect an exchange of fugitive publications on archæology. We hail with especial commendation this effort to make our scattered archæologists better acquainted.

In the *Bulletin de la Société d'Anthropologie*, 1876, M. Bertillon contributes a paper on the influence of primogeniture on sexuality. The annual births in France are, in wedlock, 105 males to 100 females, live-born; dead-born, 137–100; all births, 106.6: 100. The illegitimate births reduce the ratio to 103.1: 100. In Austria the births are 106: 100; first-borns 110.3: 100; puines, 105.2: 100. Illegitimate first-borns, 103.6: 100; illegitimate puines, 105.8: 100. In the capital cities the first-borns were 114.4: 100; puines, 106: 100. Illegitimate first-borns, 102.1: 100; illegitimate puines, 106.6: 100. The subject was ably discussed by Lagneau and others, and was reverted to in a subsequent meeting. In the same journal, page 25, Dr. Paul Topinard discusses the "parietal angle" of M. De Quatrefages. Blumenbach, in 1775, arranged skulls in a line on the floor, and observed them from above, on the *norma verticalis*. Viewed in this way the zygomatic arches are more or less prominent, giving rise to the terms cryptozygous (white races) and phænozygous (yellow races). Prichard, in 1813, added the profile and face view, *norma parietalis* and *norma frontalis*. Owen introduced the study of the base, *norma basalis*. Prichard in directing his attention to the front view of the skull, enunciated his celebrated form called ogival. To verify his experiment, De Quatrefages invented his parietal goniometer, exhibited before the Academie des Sciences in 1858, and at the French Association in 1872. The parietal angle is formed by two lines tangent to the most salient points of the zygomatic arches and to the coronal suture. When the lines meet above, the angle is positive; when they meet below, the angle is negative. The positive angle is most marked in the yellow races; the negative in the fœtus, and in some European adults.

In the third number of the *Bulletin de la Société d'Anthropologie*, M. De Mortillet has a paper on France in prehistoric times. It was read on the occasion of presenting to the society his chart on prehistoric France, prepared for Nouvelle Geographie Universelle of Elisée Réclus. Tables are given containing the number of localities in every district of the country. Something of the kind might be attempted in our own land. In the same journal are the following communications: Découverte de gisements néolithique à Moret (Seine-et-Marne). Sépulture à crémation, trépanation chirurgicale, et trépanation posthume, by M. Choquet. Étude sur une série de crânes recueillis dans le département du Puy-de-Dome, by M. Boyer. Quelques observations anthropologique sur le département du Puy-de-Dome, by M. A. Rouyon. Sur les peuples de l'Afrique Australe. Sur la langue et les traditions des Buschmans, by P. de Jouvençal. Sur deux séries de crânes provenant d'anciennes sépultures indiennes des environs de Bogota, by M. P. Broca.

The want of space prevents more than a mere reference to the following papers and works: N. B. Denny, The Folk Lore of China, 8vo, London. E. A. Freeman, Race and Language; *Contemp. Rev.*, March.

Albert S. Gatschett, Remarks upon the Tonkawa Languages, read before the Am. Phil. Soc. November 17, 1876. Intorno Agli Scavi Archeologici fatti dal Sig. A. Arnoaldi, veli presso Bologna, Osservazioni del Conte Senatore G. Gozzadini; Bologna, 1877. Albin Kohn, Die Bienenkorbgräber bei Wrobelwo, Posen; *Archiv* ix., 4, 1877. A. Ecker, Sur Statistik der Körpergrösse im Grossherzogthum Baden; Ib. Von Baer, Von wo das Zinn zu den ganz alten Bronzen gekommen sein mag? Ib. P. Cazalis de Fondouce, The Palafittes of Laibach Moor; *Matériaux*, 2, 1877. C. Engelhardt, Influence of Classic Industry and Civilization upon those of the North during Ancient Times; Ib. M. Moura, The Age of Stone in Indo-China; Ib. J. Walhouse, On Non Sepulchral Monuments; London Anth. Inst., February 27th. Rev. Thomas Powell, F. L. S., On the Nature and Use of the Vegetable Poisons, employed by the Natives of the Samoan Islands; London Linnæan Society March 15th. Rev. A. C. Cleary, The Problem of Language; Victoria Institute, March 19th. Dr. Crockley Clapham, Brain Weight of the Chinese and Pelew Islanders; London Anth. Inst., March 29th. E. B. Tylor, Review of Spencer's Principles of Psychology; *Mind*, April. J. P. Mahaffey, Modern Excavations; *Contemp. Rev.*, April. Sir. J. Lubbock, Our Ancient Monuments; *Nineteenth Century*, April. The Rationale of Mythology, *Cornhill Mag.*, April. Die Völker Russlands; *Petermann's Mittheil*, I., 1877 (good). William Tegg, Meetings and Greetings: the Salutations, Observances, and Courtesies of all Nations; London, Tegg & Co. — Otis T. Mason.

Note. We shall be glad to receive the titles of papers read before scientific bodies, or published in the journals of our country. — O. T. Mason, Washington, D. C.

GEOLOGY AND PALÆONTOLOGY.

Influence of Geological Changes on the Earth's Axis of Rotation. — Mr. George H. Darwin has presented a paper on this subject to the Royal Society. He concludes that if the earth be quite rigid, no redistribution of matter in new continents could ever cause the deviation of the pole from its primitive position to exceed the limit of about 3°. But if the view, that the earth readjusts itself periodically to a new form of equilibrium, is correct, then there is a possibility of a cumulative effect; and the pole may have wandered some 10° or 15° from its primitive position, or have made a smaller excursion, and returned to near its old place. No such cumulation is possible, however, with respect to the obliquity of the ecliptic. It is suggested that possibly the glacial period may not have been really one of great cold, but that Europe and North America may have been then in a much higher latitude, and that on the pole retreating they were brought back again to the warmth. There seem to be, however, certain geological objections to this view.

Recent Palæontological Discoveries in the West. — Prof. O. C. Marsh contributes to the July number of the American Journal of Science and Arts, the results of his studies of the *Coryphodontidæ*, a family comprising the oldest known tertiary mammals, the fossil bones coming from the base of the Eocene formation of Utah, Wyoming, and New Mexico. *Coryphodon* was an Ungulate and among the mammals associated with it were "the equine *Eohippus*, and the suilline *Helohyus*, showing clearly that we must look to Cretaceous strata at least for the parent form of the Ungulates." The paper is accompanied by figures of the skull of Coryphodon, and the feet bones of *Coryphodon* and *Dinoceras*.

(Fig. 84.) RESTORATION OF HESPERORNIS REGALIS Marsh (about one tenth natural size).

The accompanying illustration is a restoration of *Hesperornis regalis*, about one tenth of the natural size. It is a cretaceous bird with teeth, and Professor Marsh on fresh examination finds some additional characters of importance of the order *Odontornithes*, of which it is a type. He also describes a new species of small swimming bird, which comes from the same geological horizon (cretaceous) and has been called by him *Baptornis advenus*. An enormous Dinosaur (*Titanosaurus montanus*) is also described as new from the cretaceous deposits of Colorado.

On the Classification of the Recent and Fossil Fishes. — Professor Cope has recently reviewed the structure of the fossil fishes, and proposed a number of necessary modifications of the system as left by Agassiz in the *Poissons Fossiles.* He has confirmed the views of various naturalists, that the class or sub-class *Ganoidea* of that author consists of heterogeneous materials, which must be distributed in a number of sub-classes. He recognizes four sub-classes of *Pisces:* namely, the *Holocephali*, the *Dipnoi*, the *Selachii*, and the *Hyopomata.* The last named is proposed for that natural assemblage which possess a hyo-mandibular bone articulated with the cranium, a maxillary arch, and no median axis of the basal portion of either pectoral or ventral fins. Under this group he arranges three tribes, namely, the *Crossopterygia* (or *Ganoidea*), the *Chondrostei*, and the *Actinopteri;* the last made up of the *Teleostei* of Müller, and a few recent, and many extinct fishes referred by Agassiz and Müller to the "Ganoidei." Protessor Cope shows that Huxley's "suborder *Crossopterygia*," is also a heterogeneous assemblage, many of the forms referred to it belonging to the *Dipnoi*, while others are true *Hyopomata.*

The fossil fishes referred to the *Actinopteri* were found to be most nearly related to the order *Isospondyli;* none of them presenting near affinities to *Lepidosteus*, so far as discoverable. An exception to this statement, is the genus *Dorypterus*, which was regarded as typical of a new order presenting some relationship to Acanthopterygian orders. The order was named the *Docopteri.* The fossil families referred to the *Isospondyli*, are the *Sauropsidæ* (*Sauroidei* Agass. pt.), *Lepidotidæ* (*Lepidoides* Agass. pt.), *Pycnodontidæ* (*Pycnodontes* Agass. pt.), and *Dupediidæ* (*Lepidoides* Agass. pt.)

MICROSCOPY.

The New Model Illuminating Adjustment. — The plan of mounting the diaphragm, substage, and mirror upon a bar so hinged that they shall all swing concentrically around the object, now successfully and extensively carried out by both Zentmayer and Gundlach, has given rise to an unusually interesting question of priority. The fact that the Rochester stands at the Centennial Exhibition, at the time of its opening, had the mirror stem hinged slightly below the plane of the object, has been not unreasonably, though incorrectly, understood by some writers to indicate that there was at that time no intention to secure fully the advantages of the concentric swing. Mr. Gundlach, however, makes a fully conclusive explanation of the apparent discrepancy. As there is no doubt that Mr. Zentmayer had then completed and made public his invention, it cannot be doubted that both parties fully matured the plan independently.

So simple a device could hardly have escaped the efforts of previous workers. It was foreshadowed in the semi-cylinder of Mr. Tolles, with

its concentrically swinging shutter, and in the radial arm he has talked about for years in connection with the aperture question, and he even made, two years ago, for Dr. G. Bacon, of Boston, a stand with an "accessory carrier" swinging in this manner, but it does not seem to have been so formally published as to be available to the world or to constitute a claim to priority. In 1873 Mr. W. H. Bulloch, of Chicago, an optician who has made many excellent stands, constructed a large stand with the substage traversing around a point one tenth of an inch above the stage (to allow for thickness of object slide), but he did not combine the mirror bar with it, and does not now prefer to do so. Although his model lacked the completeness, simplicity, and facility of management of the latest forms, he came very near accomplishing the result which has since been attained, and contributed an important step in the progress toward that end. He also made, as early as 1870, a mirror bar to swing above the stage for using the mirror (without detaching it) for opaque illumination, and an identical device was employed by Spencer about the same time.[1] Similar arrangements have been used by others, to say nothing of the common expedient of mounting objectives or other illuminating contrivances on a swinging arm on the stand or on a separate base for oblique illumination at various angles which have been employed by the writer and nearly everybody else interested, ever since the subject of oblique illumination became prominent. It is, however, true that such an adjustment never came into general use as a regular part of the stand, and it is nearly equally certain that it is now so established as an important and permanent improvement.[2]

The following is Mr. Gundlach's account of his invention: —

"The construction of a stand with my now well-known fine adjustment, a modification of the glass stages used by many opticians, and finally the hanging of the mirror and other illuminating apparatus in the plane of the object, which had been already planned and announced before the close of the year 1875, was begun about the end of January, 1876, in the factory of the Bausch & Lomb Optical Company, after my arrangements with that company had been effected. In the construction of that stand I had in view the employment of a solid glass stage (not open in the centre), expecting to gain thereby the advantage of very oblique illumination, in consequence of the refraction of the surfaces.

"In order to obtain practically the optical object I had in view in placing the centre of rotation of the illuminating apparatus in the plane of the object, I had to take this refracting power of the solid glass stage into consideration, and consequently had to place the central point of

1 See Table of American Students' Microscopes, by R. H. Ward, M. D., in the NATURALIST for June, 1872.

2 The substance of this note was given in Dr. R. H. Ward's address as chairman of the microscopical sub-section of the American Association for the Advancement of Science, at the Buffalo meeting last August.

rotation as much under the actual (mathematical) plane of the object, as the glass stratum of the stage would have lifted the ray.

"Convinced, however, by the criticism of competent judges, and by my own observations, that the solid glass stage (without central opening) offered optical disadvantages which neutralized to a great extent the benefits that could be derived from it, I subsequently abandoned glass stages of that construction, not, however, before a number of stands had been either constructed or were in the course of construction, arranged in regard to the hinging point of the illuminating apparatus in such a manner as to suit a solid glass stage. The point selected by me for the centre of rotation of the illuminating apparatus in these stands would have been optically the correct one, if a solid glass stage of my construction had been employed.

"The stands whose construction was complete at this time, and those in process of construction, were not altered, firstly, because it would have involved considerable expense to do so, secondly, because I deemed the deviation from the actual plane of the object so slight as to be of very little consequence, especially as the actual and mathematically correct plane of the object is variable, owing to variations in thickness of the glass slides, and therefore practically unattainable for the centre of rotation, unless said centre can be made adjustable to it.

"Of these stands so made and left unaltered one was sent, with other microscope stands of our make, to the Philadelphia exhibition, and was there at the opening of the same, and the examination of this stand may have given rise to the impression that I intended to place the centre of rotation of the illuminating apparatus lower than the plane of the object. The other stands, constructed with a view of using the glass stage with central opening, and having the swinging mirror bar hinged slightly above the upper surface of the glass stage, were unfortunately not quite finished at the time the exhibition opened.

"Other stands were then in process of construction, arranged to meet the altered circumstances, and were afterwards exhibited at the Centennial Exhibition in Philadelphia, all of them conceived by me, and executed under my superintendence, before I had seen or heard of Mr. Zentmayer's efforts in the same direction."

Spencer's Objectives. — These celebrated lenses are now made by Charles A. Spencer and Sons, at Geneva, N. Y., and sold by G. S. Woolman, of New York. In addition to the usual first class series, and low angle series, there is an entirely new set called the students' series, of still smaller angle and very low price.

Exchanges. — Shell-sand from the Bermuda Islands, for any really valuable material; or selected shells from the same for mountings, of special interest. C. C. Merriman, Rochester, N. Y.

SCIENTIFIC NEWS.

— A party consisting of Dr. Joseph D. Hooker, K. C. B., Keeper of Kew Botanical Gardens, Gen. Strachey of India, Prof. Asa Gray and Prof. Joseph Leidy, have, as guests of the U. S. Geological Survey of the Territories, accompanied Prof. F. V. Hayden to Colorado, and will visit Utah and the Pacific Coast.

— The army officers at Fort Walla Walla, Washington Territory, have organized the Walla Walla Association for the Advancement of Science, Surgeon George M. Sternberg, U. S. A., being the first president. This is a new step for the military to take, and one in a good direction. We wish the new society all usefulness and success.

— Dr. Philip Pearsall Carpenter died on the 24th of May at his residence in Montreal, Canada, of typhoid fever, at the age of fifty-seven. He was born at Bristol in England, into the family of the well-known Dr. Lant Carpenter, among whose eminent children, Dr. W. B. Carpenter, Miss Mary Carpenter, and the subject of this notice, are best known. Dr. P. P. Carpenter was educated as a clergyman, and may be said to have never left off the clerical mantle, so far as a continuance of earnest labors in all matters of moral and sanitary reform may be concerned. There can be no doubt that his unceasing and enthusiastic work in this direction curtailed his opportunities for scientific study and indirectly brought about his premature death.

As a student of nature Dr. Carpenter's attention was chiefly directed to the mollusca, and especially to those of the west coast of America. The systematic study of this fauna was begun by him, and his work has rendered it practicable for others to follow him with a vast decrease of labor and bibliographical research. Thorough, careful, conscientious, frank, his reports and papers on this fauna will ever remain as his best monument.

He also gave particular attention to the *Pandoridæ*, *Cæcidæ*, and *Chitonidæ*, each of which groups he monographed in a thorough manner. The last mentioned work is yet unprinted, but is believed to be in a condition so complete as to leave little doubt that it will be published, as originally announced, by the Smithsonian Institution. It is a very remarkable monograph, and the first successful attempt to illuminate the darkness which has obscured the group of *Chitonidæ*. Malacologists are to be congratulated that this, the author's last, and in many respects most valuable effort, is not to be lost. Personally, he worked for righteousness in all his doings; no one could know without respecting the man, though his fiery enthusiasm was not always appreciated or understood. And beneath a thoroughly English bluntness of character lay an almost womanly tenderness for sorrow, ignorance, or need, in others. He married, in 1860, Miss Minna Meyer of Hamburg, a lady who has proved a helpmeet in all the work of his life, and who survives him.

He left no children and for the greater portion of his life was in very moderate circumstances. — W. H. DALL.

— Col. Ezekiel Jewett of Utica, New York, died at Santa Barbara, California, on the eighteenth of May, of pneumonia, at the age of nearly ninety years. A field naturalist rather than an author, as his martial career necessitated, Colonel Jewett was best known to those who have enjoyed his society in camp or on a collecting tour. A man of leonine bearing, tall and soldierly aspect, of brilliant conversational powers and frank and generous disposition; he combined with these a great amount of practical knowledge in some branches of science. Few were more conversant, at one time, with the fossils of New York, and he was thoroughly familiar with the marine mollusca of North America up to a pretty recent date. He was for many years curator of the New York State Cabinet of Natural History, and held other offices of trust. In literature he will be chiefly recalled by the references to collections of his making on which numerous papers by naturalists have been based. Personally he was a man whom to know was to honor and love, and he formed one of the last links between the laborers for science of his own and the present generation, a period covering more than half a century. — W. H. DALL.

— In a circular issued from the Surgeon-General's office Dr. Elliott Coues, U. S. A., asks the medical officers of the army, and others interested, to coöperate with him in the preparation of a work to be entitled History of North American Mammals, to be published by the government. Dr. Coues desires information regarding the geographical distribution of our mammals; to this end it is desirable that lists should be prepared of the various species found in any given locality, with notes on their relative abundance or scarcity, times of appearance and disappearance, the nature of their customary resorts, etc. The habits of many of the *smaller*, insignificant, or obscure species are almost entirely unknown. Full and accurate information respecting the habits of the numerous species of hares, squirrels, shrews, moles, mice, rats, bats, weasels, gophers, etc., is particularly desired. The bats offer a peculiarly inviting and little-explored field of research. Among points to which attention may be directed, in any case, are the following: —

Date and duration of the rut. Period of gestation. Usual time of reproduction. Number of young produced. Duration of lactation. Care of the young, by one or both parents. State of monogamy or polygamy. Times of disappearance and reappearance of such animals as are migratory, and of such as hibernate. Completeness or interruption of torpidity. Times of changing pelage, of acquiring, shedding, and renewing horns. Habits connected with these processes. Habits peculiar to the breeding and rutting seasons. Construction of nests, burrows, or other artificial retreats. Natural resorts at different seasons. Nature of food at various seasons; mode of procuring it; laying up of supplies;

quantity required. Various cries, of what indicative. Natural means of offense and defense, and how employed. General disposition, traits, characteristics. Methods of capturing or destroying, of taming or domesticating. Economic relations with man ; how injurious or beneficial, to what extent, used for what purposes, yielding what products of value. Specimens, after examination by the undersigned for the purposes of the work in hand, will be deposited, in the name of the donor, in the Army Medical Museum or in the National Museum. Address Dr. Elliott Coues, Office of United States Geological and Geographical Survey of the Territories, Washington, D. C.

— The Netherlands Zoölogical Association have founded an establishment on the Dutch coast, where investigations of the fauna and flora of the North Sea can be carried on at leisure. The building is made of wood, and can be transported from one place to another, according to season and varying abundance of material for study.

— In some parts of California the tomato is perennial. A resident at Los Angeles now (February) gathers ripe tomatoes from the top of a twenty-foot ladder. The vine, which is twenty-five feet high, has been trained on the sunny side of the house, and shows blossoms and fruit in every stage of growth.

— In various parts of California experiments are being made in a small way with the cork-bark oak ; and the trees are reported thus far as doing well. In Santa Barbara a fine, large, and thrifty specimen may be seen in a garden, which has grown from a seed planted twenty-two years ago.

— A farmer in Tulare County, California, has been in the habit of using for fuel the stalks of castor-beans growing on his ranch, and finds them a very ready and desirable substitute for wood, the trunks of the larger ones being about the size of a man's leg. The immense growth of this plant in a single year and its prolific bearing qualities make it a desirable crop.

— Mr. D. G. Elliot is about to publish in London two monographs, one on the *Felidæ*, including both the living and extinct species; the other on the *Bucerotidæ*, or Hornbills.

— Mr. Robert J. Creighton, resident agent in San Francisco for New Zealand, shipped early in February, by the Zealandia, a box of white-fish eggs, containing 180,000, on account of that colony. This is the second shipment of white-fish eggs to New Zealand, obtained through the United States Fish Commissioners, who pack and ship them from Lake Michigan to San Francisco. Mr. Creighton likewise forwarded for the same colony a parcel of trout eggs from the Cold Spring Trout Ponds, Charlestown, New Hampshire, and Mr. Hugh Craig, agent of the New Zealand Ins. Co., forwards on account of the Auckland Acclimatization Society two California deer and twenty-seven short-tailed grouse from Utah Territory. By the next steamer Mr. Craig will forward prairie

chickens, Oregon grouse, Oregon pheasants, and an elk for the same destination. Mr. Thomas Russell, President of the New Zealand Bank, makes a present of these animals to the Auckland Acclimatization Society.

— About four miles from San Buenaventura, California, on the river of that name, is a grape-vine of the Mission variety, the stem of which measures forty inches in circumference. It covers an area of about eighty feet in diameter. This vine yields about one thousand pounds of grapes annually. The clusters of fruit will measure from twelve to sixteen inches in length, and average three and a half pounds. It is on the ranch of Don Jose Moraga, and was planted by that gentleman seventeen years ago.

— A Natural History Review, to be called Természetrajzi Füretek (Naturhistorische Hefte), to be edited in German, was issued from the National Museum of Buda-Pesth, Hungary, about January 1, 1877. It contains papers on Zoölogy, Botany, Mineralogy, and Geology. Articles may be printed in various languages, but extracts literally translated will be given in the Hungarian text. It will be devoted wholly to Hungarian matters.

— A circular was issued December 30, 1876, by the National Society of Natural Sciences of Cherbourg, France, announcing the twenty-fifth anniversary of its foundation, and expressing great gratitude to the learned societies and its corresponding members for numerous congratulatory letters on their jubilee, which it regards as precious testimonials of esteem.

— The following facts I learned from Dr. Clark Nettleton, who now resides in Racine. It is too good a story to be lost: —

One morning in the latter part of February, 1832, the U. S. schooner Shark, Lieutenant Pierce commander, having Audubon and party on board, anchored in Cote-Blanche Bay, at the mouth of Bayou Salie, Louisiana. The scientists here left the schooner, rowed up the bayou in her boats and landed on Michael Gordie's sugar plantation.

Audubon made many inquiries about birds, where they could be found, where they roosted, etc., and all day the report of fire-arms was heard among the reeds and swamps where the men were busy procuring specimens of the birds that were so numerous there at that time.

Gordie was greatly alarmed. He consulted his overseer and interrogated the blacks with whom Audubon had talked. The conclusion was that the strangers were pirates, and that he would be robbed that night and perhaps lose his life. Thus he reasoned: "The black craft is armed, — has guns. No sane man would engage in such trifling occupation as shooting worthless little birds. This is evidently a ruse gotten up to deceive me."

So, as there was no chance of procuring assistance, the plantation being isolated by swamps and the bay, he hid his gold, secreted his

family, and barricaded the house. He then armed all hands, not a small number either, with guns, pitch-forks, cane-cutters, — everything, in short that might be of service in the emergency, and these all stood at their assigned posts, during the entire night, in the momentary expectation of an attack.

Day came, and the *piratical craft* weighed anchor and left the bay, to the great relief of the wealthy planter and his domestic army. The excitement, fear, and suspense were too much for him however. He was taken sick, and sent for his family physician, Dr. Nettleton, who lived twenty miles distant. The doctor had been apprised of Audubon's visit and had a good laugh at the expense of poor Gordie. — Dr. P. R. Hoy, Racine, Wis.

— Our readers will be pained to learn of the sudden death by apoplexy of Prof. Sanborn Tenney, July 9th, while on his way West to meet the members of the Williams College Expedition to the Rocky Mountains. We learn that the Expedition will consequently return. Professor Tenney was author of a Manual of Geology and of two on Zoölogy, which have been extensively used in schools; he also published a number of articles on geological and zoölogical subjects. He was born in Stoddard, N. H., January 13, 1827.

— A dispatch to the San Francisco papers from Los Angeles, California, under date of the 12th of June, says: A volcanic eruption occurred in the mountains opposite Flowing Wells, a station on the Southern Pacific, about sixty miles from Yuma, at 9 o'clock yesterday morning. It was preceded by a violent vibration of the earth, about half an hour after which a dense volume of smoke and huge black and broken bowlders were observed to issue from the mountains. It continued in an active state all day, but became nearly passive at nightfall. Subsequent dispatches confirmed the above, and a recurrence of the eruption is reported.

— After delays which the editors of *Psyche*, the only American journal of entomology in existence, except the Canadian Entomologist, could not avoid, the first numbers of the second volume have been issued to subscribers. The second volume will be made superior in quality and in quantity to the first. Subscriptions are earnestly desired, in order that the almost inevitable drain upon the purses of the publishers may be as small as possible. We regret to learn that the first volume of this valuable little journal cost more than two hundred dollars beyond the receipts from subscriptions, and the editor had to pay most of the deficit. The subscription price to either the first or the second volume (embracing three years each) is three dollars.

— The Woodruff Scientific Expedition around the world proposes to sail in October, and return in October, 1879. We have received the "Final Announcement," a pamphlet of thirty-nine pages, with a map of the route.

— From the report of a recent lecture by Prof. A. E. Verrill on the construction and arrangement of the new Peabody Museum at Yale College, with especial reference to the zoölogical department, we learn that the collections are nearly arranged. The first story is devoted to geology and mineralogy, the second to palæontology, and the third to zoölogy. Prof. Verrill's laboratory is 42 by 22 feet, and Prof. Smith's 36 by 26 feet. They are on the same floor with the collections. The cases in the exhibition rooms are probably superior to those in any museum in this country. Their special merits are, first, *tightness*, to prevent access of dust and moths; second, transparency, to give the best possible view of the contents, which has been accomplished by the use of the best plate glass both in the sides and ends, and by reducing the woodwork to the smallest size compatible with requisite strength. To make the cases as tight as possible the doors are provided with tongue and groove, with patent locks that bolt the doors at top and bottom. In the zoölogical department the cases have also been decidedly improved in this respect by the use of sheet-zinc for backs. Another peculiar feature, quite novel, so far as known, is the use of large panes of ground-glass, ground on both sides, and set in movable sash, for the central divisions in the alcove cases. This gives an admirable background for the specimens, and also gives increased light in the room. Moreover, such backs are not liable to the unsightly shrinkage cracks so frequently seen in wooden backs.

— Mr. Edwin Bicknell, well known for his skill in practical microscopy, died at Lynn, Mass., March 19th, aged forty-seven years. Mr. Bicknell became interested in work with the microscope about twenty years ago, and his first specimens were prepared at the Portland Society of Natural History, in Maine, his native State. He soon acquired great reputation as a preparer of injected specimens and rock sections; and his examples of these objects have never been surpassed. He succeeded Mr. Glen as microscopist to the Museum of Comparative Zoölogy, under the late Professor Agassiz, and went to the Penikese School as demonstrator of the microscope. He also took a prominent part in the meetings of the Microscopical Sections of the Boston Society of Natural History, and the American Association for the Advancement of Science. His connection with Cambridge ceased at the death of Agassiz, and for a while he resided in Salem, Mass., where he had before held a place in the Essex Institute Microscopical Works. His last work was in the illustration by microscopic projections of various scientific lectures. Mr. Bicknell was a laborious student of the theory and history of the microscope, and leaves a very fine library of books, old and new, on his favorite subject. — E. C. Bolles.

— Catalogus Polyglottus Historiæ Naturalis a Carolo Gilberto Wheeler, Professore in Universitati Chicagensi, is the title of a folio giving the names in English, Latin, Italian, French, and German of a

number of animals and minerals taken at random. What could have induced any one to spend his time in such utterly unprofitable work as this, we are at a loss to imagine.

— Dr. John S. Bowerbank, well known for his researches in the sponges, died at the age of eighty, March 8th. Professor Panceri recently died while lecturing to his class at Naples.

PROCEEDINGS OF SOCIETIES.

Boston Society of Natural History. — April 18th. Mr. C. S. Minot made a communication on the primitive homologies of the animal kingdom, based on a new theory of the germinal layers.

May 2d. Mr. S. W. Garman read a paper on the pelvis of Selachians, with especial reference to that of the genera Potamotrygon and Disceus.

May 16th. Mr. M. E. Wadsworth remarked on the fusibility of some forms of quartz; on the mineralogy and petrography of Boston and vicinity, and on the granite of North Jay, Me. Mr. Scudder described a fossil cockroach probably from Pennsylvania, and referred to some points hitherto overlooked in the structure of the book-louse.

American Geographical Society. — New York, May 7th. Mr. J. A. Johnson lectured upon Some Geographical Features of California, and Mr. A. R. Conkling read a paper entitled A Summer's Exploration in the Sierra Nevada.

May 22d. Addresses were made on the Exploration and Civilization of the Interior of Africa and the Suppression of the Slave Trade, by Revs. J. B. Pinney, H. W. Bellows, Prof. A. Crummels, Paul B. Du Chaillu, and Judge Daly.

Appalachian Mountain Club. — Boston, June 13th. Mr. J. R. Edmands exhibited his improved camera for mountain surveying. Mr. W. H. Pickering showed a new form of plane-table for the same purpose. Prof. C. R. Cross described some measurements of heights by the barometer. On June 16th the club joined the Lexington Field and Garden Club in a field-meeting, at Lexington.

Academy of Natural Sciences. — Philadelphia, May 22d. Dr. Koenig placed on record the occurrence of enstatite associated with corundum from Lincoln County, Georgia, received for examination from Dr. Foote.

Mr. John Ford described a group of eight burial mounds examined by him on the lands of Mr. E. P. Ford, on Coups Creek, Macoupin County, Illinois. The scene presented upon opening the third grave was somewhat startling in character. Four skeletons set within it, two and two; their arms crossed, the knees of one pair pressing sharply against the backs of the other, and the faces of all, like those in the central grave, turned directly towards the east. The enveloping earth

was not so dense nor the quantity so large in proportion as in the other graves, so that most of the upper parts of the skeleton were exposed to view upon lifting the covering slab. In addition to the human remains nothing was found except four large marine shells, known as the *Busycon perversum* of Linnæus. The position of each of these in relation to the bodies was the same. The canal or smaller end of the shell had been placed in the right hand of each individual, while the larger portion rested in the hollow above the left hip. But more remarkable than this was the fact that within each of the shells had been packed what appeared to be the bones of a child, the skull, which evidently had been crushed before burial, protruding beyond the aperture. It was difficult to resist the conclusion that these infants were sacrificed as offerings to the spirits of the dead whom the living desired to honor.

Dr. Leidy remarked that while strolling along the sandy beach at Cape May, N. J., he observed that in a number of places, where the water of hollow beds had sunken away in the sands, a thin, yellowish-green film colored the surface. A portion of this green matter was scraped up and put in a bottle with sea water. The heavier sand subsided and the green matter remained in suspension, giving the water an olive-green color, reminding one of the colored turbid liquor decanted from a jar of stale preserved olives. The color was suspected to be due to the presence of diatoms, but on microscopic examination it proved to be caused by multitudes of a greenish monad, probably pertaining to the genus Chilomonas. The minute flagellate infusorian is discoid oval in form, with a slight emargination laterally. This emargination seems to indicate the position of the mouth, and from it projected a single delicate flagellum, or thread, scarcely distinguishable. The little creature moved active forward, rolling over from one side to the other, and rapidly vibrating the flagellum. Under a high power the animal appeared transparent and nearly colorless, with two or three balls, of yellowish green hue, and several transparent, colorless, and well-defined globules. The size of the monad ranged from 1-4000 to 1-2400 of an inch in length, but what they lacked in size they made up for in numbers, large patches of the beach being colored by them.

California Academy of Sciences. — May. By Mr. J. A. Hosmer a skull and stone mortar was presented. They were found on Anacapa Island, at the base of an artificial shell mound, the mound one of a number, and the shells chiefly those of abalone (Haliotis) and (Mytilus) mussel. Fragments of flint were scattered around, evidently left there by arrow-makers. Fossils of leaves from the intercalated clays in the auriferous gravels, near Blue Tent, Nevada County, were presented by D. P. Hughes. Mr. S. B. Christy, of the University of California, read a paper entitled Some Notes on the Mount Diablo Coal Mines, etc. It gave an analysis of the various grades of coal in the Mount Diablo field, and in those of Livermore Valley, California, and Washington Territory.

Mr. R. E. C. Stearns read a memorial sketch of the life and scientific services of the late Col. Ezekiel Jewett, who died at Santa Barbara, California, on the 18th of May, at the age of eighty-six years.

Through inadvertence we omitted to state that the wood-cuts illustrating Prof. Russell's article "Concerning Footprints" in the July number, were kindly loaned by Messrs. Ivison, Blakeman, Taylor, & Co., the publishers of Dana's Manual of Geology, from which the cuts were taken.

Professor E. S. Morse is now in Japan studying the anatomy and development of the Brachiopods. He will be absent from the country until October.

A Manual of the Anatomy of the Invertebrated Animals by Prof. T. H. Huxley will be issued in August, by J. & A. Churchill, London.

SCIENTIFIC SERIALS.[1]

American Journal of Science and Arts. — July. Germination of the Genus Megarrhiza, by A. Gray. On the Relations of the Geology of Vermont to that of Berkshire, by J. D. Dana. Characters of Coryphodontidæ, by O. C. Marsh. Characters of Odontornithes, by O. C. Marsh. New and Gigantic Dinosaur, by O. C. Marsh.

The Geographical Magazine. — June. The Arctic Expedition, xv. Work of the Auxiliary Sledge Parties. The Seat of War in Asia, Corea, by S. Mossman. The India-Rubber Trees in Brazil, by R. Cross.

The Geological Magazine. — May. A Visit to the Active Volcano of Oshima, by J. Milne. June. — On the Rocks of Newfoundland, by J. Milne, with Critical Notes by A. Murray. Baron C. von Ettinghausen's Theory of the Development of Vegetation on the Earth, by J. S. Gardner.

Quarterly Journal of Microscopical Science. — July. Résumé of Recent Contributions to our Knowledge of Fresh-Water Rhizopoda, Part IV., by W. Archer. Notes on the Structure of several Forms of Land Planarians, etc., by H. N. Moseley.

Annals and Magazine of Natural History. — May. Malacological Notes, by R. Garner. On the Final Stages in the Development of the Organs of Flight in the Homomorphic Insecta, by J. Wood-Mason. June. — On the Variability of the Species in the Case of Certain Fishes, by V. Fatio. On Ascodictyon, a New Provisional and Anomalous Genus of Palæozoic Fossils, by H. A. Nicholson. On Rupertia Stabilis, a New Sessile Foraminifer from the North Atlantic, by G. C. Wallich.

The Quarterly Journal of Conchology. — May. Review of the Genus Tulotoma, by A. G. Wetherby.

[1] The articles enumerated under this head will be for the most part selected.

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REPRODUCTION IN FRESH-WATER ALGÆ.

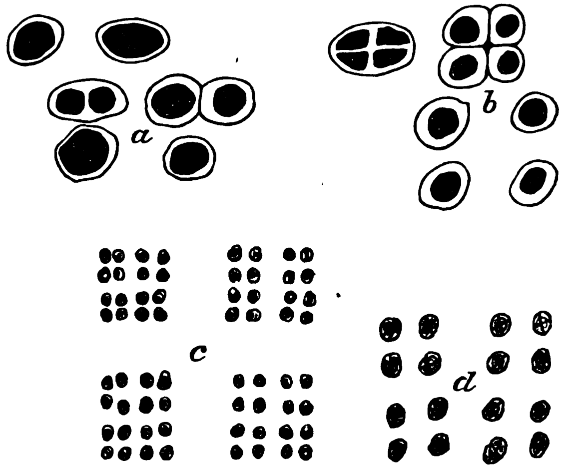
BY BYRON D. HALSTED, M. S.

AMONG the higher forms of vegetable life, two distinct methods of reproduction have long been observed, namely, by means of seeds and through some outgrowth from the parent plant. The first method is styled the sexual form, because there is involved in the production of a seed the male element, represented by the pollen grain, and the female part called the embryonal vesicle. In fact, it is the blending of the contents of two separate and distinct cells to form a germ, which under favorable circumstances is capable of producing a plant like the one from which it came. Under the second method fall all those forms of continuing the species other than by means of seeds, which are very common in nature and extensively practiced in the art of horticulture. In essence this is nothing more than multiplication by offshoots or by removal of parts of plants, which when naturally or artificially separated will continue to live and grow.

Let us pass by the interesting and more familiar field of sexual and asexual reproduction among Phænogams, and spend a few moments in looking at these same methods as shown to us by the Algæ of our fresh-water ponds and streams.

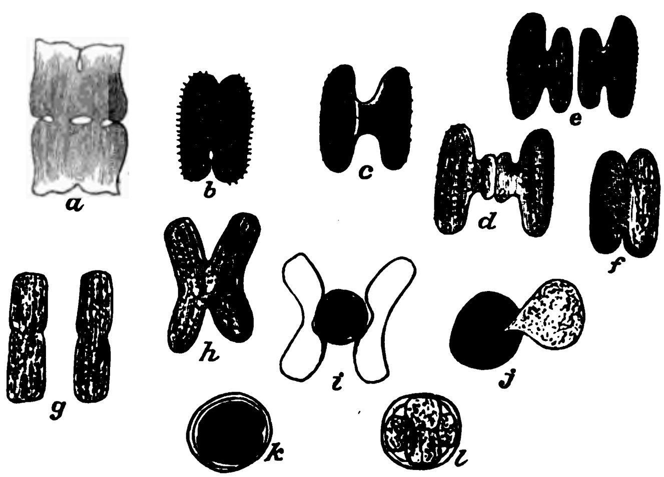
When we have a plant consisting of a single cell, and in the process of time the walls of that cell close in and divide it into two separate and similar cells, each of which soon attains the normal size and divides again in the same manner, we have the clearest illustration of asexual reproduction. The lowest forms of fresh-water Algæ furnish thousands of such examples, where the offshoot and parent plant are not distinguishable because equal in all respects; and in which division of cells results in the multiplication of individuals in the ratio of one to two, as shown in Figure 85, *a*. In other cases the division is not so simple, for, instead of each dividing into two cells, a single unicellular in-

dividual forms four plants, each of which in turn gives rise to four more, so that often, under the microscope, these divisions can be traced through several generations on account of the difference



(FIG. 85.) DIVISION OF CELLS IN ALGÆ.

in size of the individuals and the relations which they bear to each other in space. (Figure 85, *b*, *c*, and *d*.) This simple asexual reproduction is the only method known in these lowest forms of plants.



(FIG. 86.) MULTIPLICATION OF DESMIDS BY DIVISION.

The Desmids form a large group of unicellular fresh-water plants, which have attracted much attention and study owing to the variety and beauty of the forms and markings which they

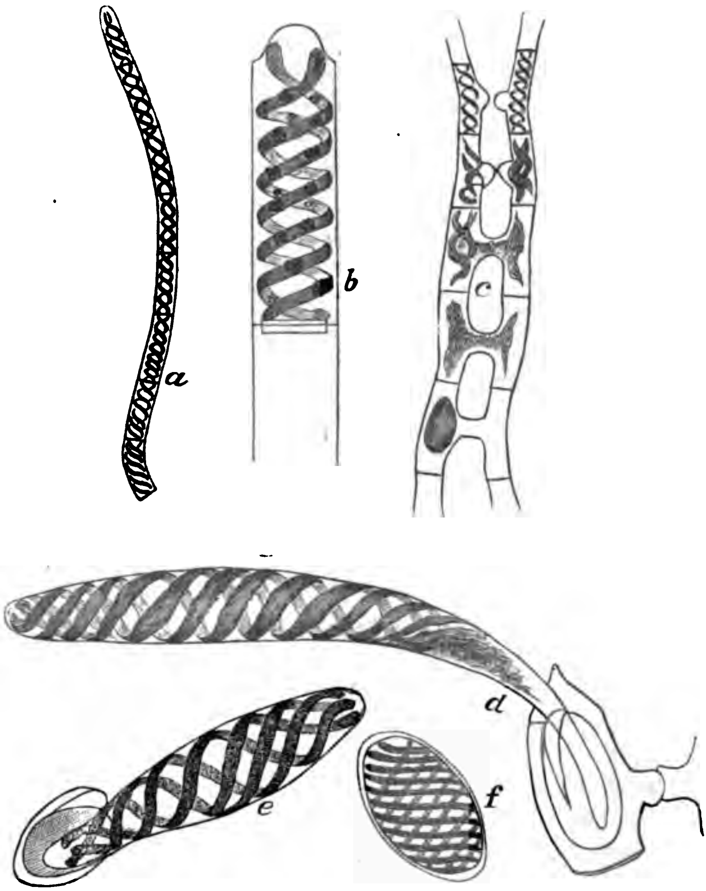
present. The general form of a desmid is usually very symmetrical, it being composed of two parts, of which the one is the exact counterpart of the other. (Figure 86, *a* and *b*.) The asexual form of reproduction is a cell multiplication by division, but differs somewhat from the cases already mentioned. When two desmids are to be made out of one, the first process is the elongation of the neck or part by which the two halves join (*c*). "By this time a new wall has formed inside each half of the isthmus and stretches also across its cavity, forming with its fellow a double partition wall separating the two halves of the old frond. Rapid growth of the newly formed parts now takes place, the central ends become more and more bulging as they enlarge, and in a little time two miniature lobules have shaped themselves at the position of the old isthmus [*d*]. At last, the parts thus formed having assumed the shape and appearance of the original lobules, the two fronds which have been developed out of one separate mostly before the new semicells [*e*] have acquired their full size."[1] This is much the most common form of reproduction, the other being the sexual method, and in one sense a process directly opposite to the one just described, it being the union of two cells to form one. When it is to take place, the outer walls of two desmids lying near each other burst open and the contents of each cell, with its thin inner wall, protrude; these finally blend, and the contents of the two cells flow into one mass (*i*). This new cell thus produced soon takes on a thick outer coat which is frequently ornamented with spines and other markings, and the ultimate result of the whole process is a spore.

In the Desmids the two cells which unite exhibit no sexual differentiation, and botanists have given to all such cases the name of *conjugation* in distinction from *fertilization*, where the male and female organs are apparent. But what becomes of the product of the two conjugated cells? It is a resting spore provided with a thick outer coat, and may sink to the bottom of the pond, where it remains through the winter. When the time for germination arrives its contents divide into a number of masses, each of which becomes a young desmid surrounded by a cell-wall of its own, and is turned out to take care of itself when the wall of the spore is broken away.

Thus far we have looked only at plants which are distinctly unicellular. Now we come to those that are made up of a number of single-celled individuals capable of existing alone, but usually arranged end to end in the form of filaments.

[1] Wood's Fresh-Water Algæ.

The members of the genus Spirogyra are very common in fresh-water ponds, making up much of the filamentous "scum" often seen on the surface. They are easily recognized under the microscope by their green spiral bands of chlorophyll (Figure 87, *a*, and still more enlarged in *b*). New individuals are formed by the simple division of the old cells by means of a partition wall

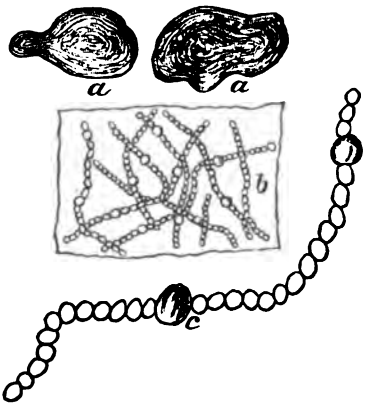


(FIG. 87.) REPRODUCTION OF SPIROGYRA.

through the middle; each half then grows to the normal size and again divides, thus increasing the length of the filament. Conjugation takes place between the cells of adjoining filaments. The first perceptible change is a contraction in the spirally arranged protoplasmic contents into a somewhat compact and irregular mass, followed by a bursting of the cell-wall, out of which a process is pushed, which, meeting with another similar one from

an adjoining cell, blends with it, and the contents of one cell pass over into the other. Two filaments can frequently be found lying nearly parallel, the cells of the one filament conjugating with those of the other throughout the whole length. In conjugation the deep green spiral bands are therefore destroyed, and in their place the dark brown spores are produced; so that in a floating mass of Spirogyra, when this process takes place, the beautiful green is lost and a pale, sickly, dirty material is seen in its stead, appearing as if dead when in reality only preparing itself to live over until another spring. Germination takes place by the contents of the spore pushing out into a filament, as shown in Figure 87, *d*, *e*, and *f*, drawn after a plate by Pringsheim, a noted cryptogamic botanist.

In the genus Zygnema, quite closely related to the Spirogyra, the spores often do not form in either of the cells, but remain in the enlarged centre of the uniting tube, leaving both filaments empty and giving a ladder-like appearance to the whole affair. Again, in other closely related genera, conjugation takes place between the adjoining cells of the same filaments by different methods in different species. In some a small tube is thrown out from each of the two cells, which meet and form a passage for the transfer of the contents of one cell to that of the other.

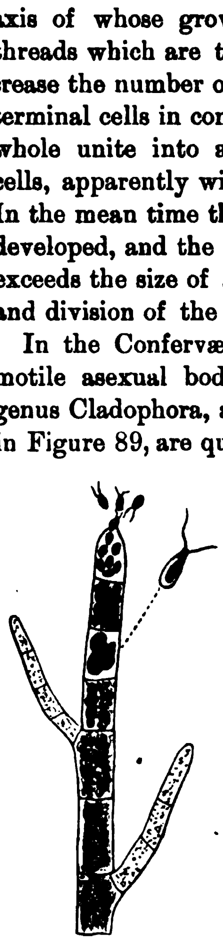


(FIG. 88.) NOSTOC.

The Nostocs grow in water, but are more commonly found on damp ground as gelatinous spherical masses or colonies (Figure 88, *a*, *a*). When a small portion of one of these slippery balls is placed under the microscope it is seen to consist of a multitude of filaments, resembling strings of beads, imbedded in an amorphous jelly (*b*). In these strings there are at irregular distances certain cells, larger than the others, called heterocysts. In speaking of the method of reproduction of these plants we cannot do better than employ the language of Thurets, who has made a thorough study of them. He says: "The jelly of the old colony becomes softened by water, the portions of the threads lying between the heterocysts become detached, separate from the jelly and straighten, while the heterocysts themselves remain in the

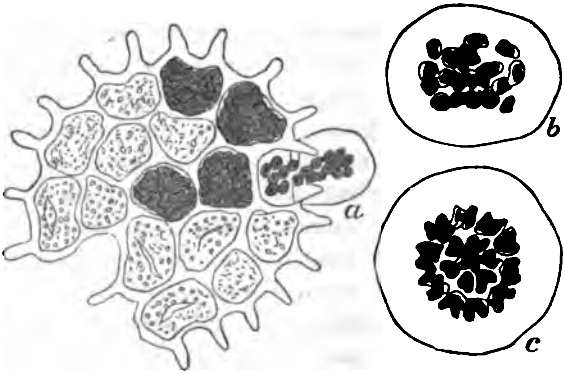
jelly. After they have entered the water the old portions of the thread become endowed with motion, like the oscillatoreæ, and their exit is apparently caused by this movement. The roundish cells of the filaments now grow transversely, that is, vertically, to the axis of the filament, become disk-like, and then divide, the division planes being parallel to the axis of the old filament, which now consists of a series of short threads, the axis of whose growth is vertical to its own. The numerous threads which are thus formed continue to elongate and to increase the number of their cells; they then curve, place their two terminal cells in contact with those of the next row, and thus the whole unite into a single curved Nostoc-filament. Individual cells, apparently without any definite law, become heterocysts. In the mean time the gelatinous envelope of the new filament is developed, and the original microscopic substance attains or even exceeds the size of a walnut by continuous increase of the jelly and division of the cells."

In the Confervæ family reproduction is effected by means of motile asexual bodies called *zoöspores*. The members of the genus Cladophora, a portion of one of which is highly magnified in Figure 89, are quite common, deep green, irregularly branched algæ. When these zoöspores are to form, the protoplasmic contents of certain cells contract into oval masses, each of which upon its escape through the broken cell-wall moves away in the water by means of two vibratile cilia which are attached to one end of the spore. This rotary and progressive motion lasts for some time, after which the body comes to rest, loses its cilia, and, attaching itself to some support, germinates and produces a new Cladophora. There are frequently two distinct sizes of these asexual spores produced in separate cells of the same plant, as seen in the figure; the large ones are called macrozoöspores, and the small ones microzoöspores. It has been stated by Pringsheim that the microzoöspores conjugate, in which case we would have sexual action taking place between asexual spores. It is certainly quite interesting to see these little animal-like bodies moving rapidly around inside the mother cell, as well as darting away upon making their exit. Sometimes two or more



(FIG. 89.) CLADOPHORA.

will reach the opening at the same time when there is room for the passage of only one at a time, and even here among these protoplasmic forms there seems to be an exhibition of selfishness often bordering on wrath.



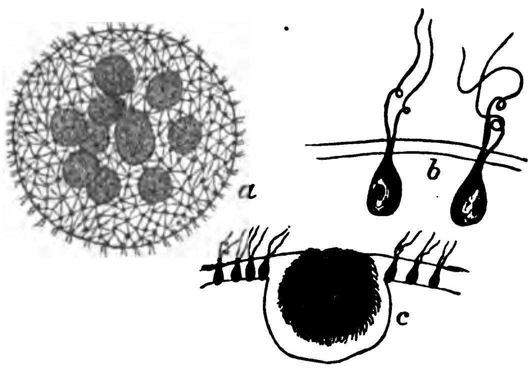
(FIG. 90.) PEDIASTRUM.

The family to which the Pediastrum belongs is distinguished by each cell forming a large number of motile spores, which remain together as they escape, and grow into a new disk-shaped cluster. In Figure 90 (which is a copy from A. Braun) is shown an old community where many of the cells have discharged their contents in a manner seen at *a*. Soon after the escape of a cell's contents a form as shown at *b* is assumed, the cluster being surmounted by a mass of jelly. A more advanced state of development is given at *c*, where the form of the mature community is discerned.

(FIG. 91.) VAUCHERIA.

The genus Vaucheria is a large one, and is made up of species of green, single-celled, often branching algæ, which grow most frequently on the moist borders of fresh-water streams. These plants are pleasant ones to study, and exhibit very well both sexual and asexual methods of reproduction. At *a* in Figure 91 is an enlarged portion of a filament, from the tip of one branch of

which a part of the contents is escaping, while in the other branch an oval body is seen. These represent the asexual spores, a more enlarged example of which is seen at *c*, and are nothing more than portions of the green protoplasmic contents of the filaments which contract and escape through the rupture at the tip. These spores are covered with a number of cilia, by the movement of which they are able to move about quite rapidly for a short time; then, coming to rest, they germinate, and produce a new Vaucheria. When a sexual spore is produced the process is somewhat different. At certain points on the filament, not far distant from each other, two projections arise: the one grows more slender than the other (*d*) and becomes much twisted upon itself. This is the male organ, called *antheridium*, and in it are produced the *antherozoids*, small bodies (*e*) provided with two cilia for movement; they resemble the zoöspores of the Cladophora, though having a quite different office to perform. The other projection is the



(FIG. 92.) VOLVOX.

female organ, *oögonium*, and is usually of an ovoid shape and filled with granular matter. When the time for fertilization comes, the wall of this organ is ruptured at the end nearest the antheridium, from which there passes out at the same time a mass of antherozoids, some of which find their way to the contents of the oögonium and fertilize it. Soon a new growth takes place in this newly fertilized body, and a double cell-wall is formed over it, the whole becoming a well-protected, resting spore; it is provided with no cilia and therefore has no movement of its own.

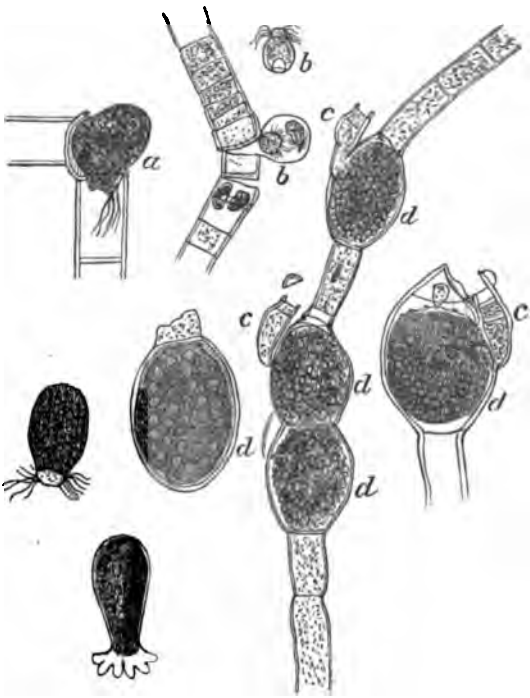
Is it not easy to trace the similarity between the sexual reproduction of Vaucheria and that of flowering plants?

The Volvocineæ comprise a peculiar group of plants, the mem-

bers of which are always in motion, and for this reason have often been classed in the animal kingdom. Figure 92, *a*, gives an enlarged view of a Volvox, which has the general appearance of a sphere studded over with a multitude of bodies arranged at quite regular distances and provided with two cilia. An enlarged view of a section of the outside of one of these spheres, with two of these ciliated bodies, is shown at *b*. Each of these bodies is considered an individual, and therefore the whole sphere is, like an oak-tree or grape-vine, a community of individuals. Asexual reproduction takes place by one or more of these individuals increasing rapidly in size and their contents dividing up into what are to develop into new individuals, forming thus a number of young communities within the old one, several of which are shown as dark, round bodies in *a*. When these young spheres have attained considerable size (*c*) they escape and become free and independent colonies. "The succession of generations of motile families is brought to an end by the formation of resting spores. The separate primordial cells of the last motile family lose their cilia, and surround themselves with a firm, closely adherent cell-wall. They accumulate at the bottom of the water, and there grow into large green balls, the color of which passes over when mature into red. Only when these resting cells have remained dry for a long time are they in a condition when again moistened to develop gradually generations endowed with motion. The sexual reproduction is brought about in this family by the gelatinous envelopes of the young families softening and setting free the separate cells, which move around by means of their cilia. When two of these cells meet they coalesce into a single body, the spore, which germinates and produces a new community after a period of rest."

Members of the genus Œdogonium grow frequently in stagnant pools and are not very attractive to the naked eye, though when viewed through the microscope they become objects of interest to many. Their somewhat complicated methods of reproduction are given so clearly by J. Sachs, in his Text-Book of Botany, that we cannot refrain from using his language in describing them, as well as copying the plate which he uses from Pringsheim. "The reproduction of the Œdogonieæ takes place by asexual swarm-spores and by oöspores produced sexually. An alternation of generations takes place in the following manner: From the oöspores which have remained at rest for a considerable period, several (usually four) swarm-spores are immediately formed,

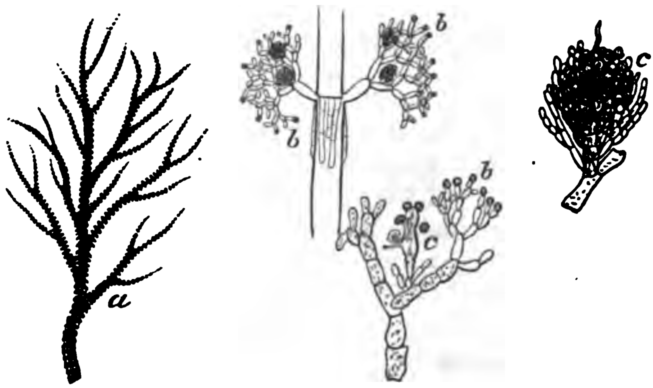
which produce asexual, that is, swarm-spore-forming plants, from which similar ones proceed, until the series of them is closed by a sexual generation (with formation of oöspores); but the sexual plants produce swarm-spores as well. The sexual plants are either monœcious or diœcious: in many species the female plant produces peculiar swarm-spores, out of which proceed very small male plants (dwarf males). The swarm-spore is developed in an ordinary cell of the filaments by the contraction of its whole protoplasmic substance (Figure 93, *a*); it becomes free from the



(FIG. 93.) ŒDOGONIUM.

mother-cell, the cell-wall splitting by a transverse slit into two very unequal parts. The swarm-spore is encircled at its hyaline end — the anterior end during swarming — by a crest of numerous cilia. The spermatozoids are very similar in form to the swarm-spores, but much smaller (*b*, *b*); their motion, due to a crest of cilia, is also less. The androspores, from which the dwarf male plants arise, are produced from mother-cells similar to those which give birth to the spermatozoids. After swarming they fix themselves to a definite part of the female plant, on or near the oögonium, and after germination produce at once the antheridium-

cells, and in them the spermatozoids (*c*, *c*, *c*). The oögonium becomes at first more completely filled with contents than the remaining cells; immediately before fertilization the protoplasm contracts and forms, as in Vaucheria, the oöspore, in the interior of which the grains of chlorophyll are densely crowded. Immediately after fertilization the oöspore surrounds itself with a membrane which afterwards, like its contents, assumes a brown color. The oöspore remains inclosed in the membrane of the oögonium, which separates from the neighboring cells of the filament and falls to the ground, where the oöspore passes its period of rest. When it awakes to new activity the oöspore does not itself grow into a new plant, but its contents divide into four swarm-spores, which escape together with the inner skin of the oöspore, and, after this latter is dissolved, swim away. After becoming stationary each grows into a new plant."



(FIG. 94.) BATRACHOSPERMUM.

The last example, under this head, which space will admit of giving is one of a very few members of the family of red seaweeds, which condescends to live in fresh water, namely, Batrachospermum, or, as it is commonly called, frog-spittle. It grows in tufts upon the rocks and pebbles in the bottom of running streams, a small portion of which is shown in Figure 94, *a*, as it appears to the naked eye. The plant is made up of a central axis with a large number of branches radiating from it at quite regular intervals, giving a necklace-like appearance to the filaments. The male element is in the shape of small cells borne singly on the tips of the branches (*b*, *b*). The female part is a large, peculiar-shaped cell situated on a main branch down near the central cylinder (*c*). The antherozoids have no cilia, and fall from their attachments and are carried about by the water. When

one or more of them come in contact with the upper portion of the female cell they blend with it and their contents are absorbed and fertilization is effected. Soon a rapid growth of filaments and cells takes place at the base of the female organ as a result of this fertilization. In fact there is formed a naked cluster of spores (*c*) from these filaments, all fertilized by the single sexual act upon the central female cell.

In these few pages the endeavor has only been to point out a few of the leading methods of asexual and sexual reproduction among fresh-water algæ, and we feel in closing that the vast subject has been but here and there touched upon. But enough has been said to show that even in these lowly forms the *too often supposed* sameness of reproduction loses itself in variety of methods and multiplicity of changes.

SURFACE GEOLOGY OF THE MERRIMACK VALLEY.[1]

BY WARREN UPHAM.

THE highest fountains of Merrimack River are Eagle Lakes, on Mt. Lafayette, 1090 feet below its summit and 4170 above the sea. The source of the straight river is a lake which lies in the deep Franconia Notch, beneath the jutting rocks of the Profile. This stream is at first inclosed by high mountain ranges, and descends more than 1200 feet in its first nine miles. Distances and heights along this river are as follows: Profile Lake, about 1950 feet above the sea; mouth of East Branch, 9 miles, 710; at Plymouth, 28 miles, 468; at New Hampton, 39 miles, 438; mouth of Smith's River, two miles below Bristol, 45 miles, 320; mouth of Winnipiseogee River at Franklin, 55 miles, 269; mouth of Contoocook River at Fisherville, 66 miles, 249; mouth of Soucook River, 76 miles, 199; Amoskeag Falls at Manchester, 89 miles, 179 to 123; at line between New Hampshire and Massachusetts, 108 miles, 90; Pawtucket Falls dam, Lowell, 117 miles, 87; Essex Company's dam, Lawrence, 128 miles, 39. The entire length of this river is about 155 miles, and its last twenty miles are affected by the tide.

The Merrimack Valley in New Hampshire is comparatively straight, and forms a continuous line of depression which is a principal feature in the topography of the State. Its course is

[1] This essay is principally based upon explorations made for the Geological Survey of New Hampshire, and will be more fully presented in vol. iii. of the report on that survey.

slightly east of south. The upper and lower portions of the river which occupies this valley are known by different names. For more than fifty miles from its source, this river is called Pemigewasset; and the name Merrimack is applied to it only from the confluence of the Winnipiseogee River with the Pemigewasset at Franklin.

After entering Massachusetts the river turns to the east at North Chelmsford, and thence pursues a devious east and northeast course at right angles to its valley in New Hampshire. It here threads its way among hills, with no distinct, wide valley; and only low water-sheds divide it from adjoining basins on the south.

In considering the surface geology of Merrimack Valley, we will begin at its head and describe first the modified drift which forms conspicuous plains, terraces, and intervals or bottom-lands along its course in New Hampshire, and occurs in gravel ridges, similar to the *Kames* of Scotland, well shown at many places along the whole course of this river; next, the prominent rounded hills of coarse glacial drift or *till*, which are finely displayed along this river in Massachusetts; and, last, the marshes and beaches at its mouth. After this, we will inquire what these deposits teach in regard to the history of this valley in the glacial age, during the melting of the great northern ice-sheet, and since that time.

The modified drift of the upper part of the Merrimack, called Pemigewasset River, is usually one half mile to one mile wide, and is bordered on both sides by high hills or mountains. Below Franklin the modified drift is usually one to two miles wide; its greatest development is in Concord, in Merrimack, and in Litchfield, where it has a width of nearly four miles. The hills which border this part of the valley rise with comparatively gentle slopes, and the lowest points of its eastern water-shed are only three hundred and fifty to six hundred and fifty feet above the sea.

On Pemigewasset River modified drift occurs first in Lincoln, five miles from Profile Lake. This is very coarse, water-worn gravel, containing pebbles six inches to one and a half feet in diameter, or sometimes larger. It has an irregularly smoothed surface, imperfectly terraced, with its outer margin twenty feet above the stream. From this point modified drift is continuous on one or both sides of the river for thirty miles. In the first seven miles, to Woodstock village, it consists wholly of gravel of

different degrees of coarseness. Southward, banks and terraces of sand begin to appear, but gravel still predominates for a long distance below. The stream here frequently occupies a broad, shallow channel paved with pebbles of all sizes up to two feet in diameter, with little admixture of fine gravel or sand, which accumulates only in deep or sheltered places.

For ten miles south from the mouth of East Branch, or nearly to the south line of Thornton, a high terrace of gravel or sand is commonly well shown on both sides of the river, and has a uniform, continuous slope of fifteen feet to the mile. This slope is nearly the same as the descent of the river, which has evidently swept away this deposit to a depth of from seventy to one hundred feet over the area occupied by its channel and bordering bottom-land or interval. Nowhere else in New Hampshire is the erosion of the modified drift, by which it has been shaped in terraces, so clearly displayed. Here it seems certain that a former flood-plain, ten miles long, has been terraced as we see it by the excavation of the river.

In Campton the Pemigewasset receives two considerable tributaries from the east, Mad and Beebe rivers, which drain basins on the northwest and southeast of the mountain range that culminates in Sandwich Dome. South of the Beebe River the upper terrace, increased in height by alluvium from the tributary, forms a pine-covered plain, one mile long and a half mile wide. These "pine plains," appearing in a few places on the Pemigewasset and commonly along the Merrimack, form one of the characteristic features of this valley.

In Plymouth and Holderness both the high plain and interval are finely shown, and the extent of the alluvial area, at one point a mile and a half wide, is greater than at any other place on Pemigewasset River.

Dunes. In the north part of New Hampton and in many places for thirty miles southward to the north line of Concord, we find numerous dunes or sand-drifts lying at various heights on the east side of the valley up to three hundred feet above the highest terraces. These dunes appear in large amount and reach their greatest height near their beginning, two miles south of Ashland. Here the sand-drifts, one to five feet deep, are strewn in a pathway ten to twenty rods wide, which extends a quarter of a mile along the hill-side, with a northwest-southeast course, rising three hundred feet above the ordinary modified drift, or to a height about eight hundred and fifty feet above the sea.

These dunes occur only on the east side of the valley, consist wholly of fine sand, and lie in trains which ascend from the highest terrace in a southeast direction along the hill-side. All these characteristics indicate that they owe their origin to the transportation of sand, by the prevailing northeasterly winds, from the plains below, probably at the period when these had their greatest extent, prior to their excavation by the river, and, we may presume, before the appearance of a forest. They are usually made conspicuous at the present time by being blown in drifts, which are so constantly changing that they give no foothold to vegetation; but when they occur at considerable heights the lower portion of the series is generally grassed over, making the upper drifts appear isolated on the hill-side. The whole train of dunes before mentioned is equal by estimate to a mass one thousand feet long, fifty feet wide, and two feet deep, thus containing one hundred thousand cubic feet or five thousand tons, which has been raised by the wind an average height of one hundred and fifty feet.

Another very good illustration of this transporting power of the wind is found in Sanbornton, one mile southeast from Hill. Here, as also in New Hampton, the ancient dunes have been swept forward anew since the land was cleared. The sand from a hollow one hundred and fifty feet long, forty feet wide, and two to five feet deep has been carried, in long northwest-southeast drifts, two hundred to four hundred feet farther and twenty-five to thirty feet higher up the hill. The depth of recent excavation is shown by a large stump which has been thus undermined.

Similar dunes, high above the ordinary modified drift, occur along the east side of Connecticut River in New Hampshire and southeast from Ossipee Lake.

From New Hampton to Bristol the river flows westerly, almost at right angles with its general direction, descending by a nearly continuous slope eighty-six feet in the four miles, this being the most rapid portion of its course south of East Branch. Here it is closely bordered by sloping hills, and differs from all the rest of this valley in New Hampshire in being well-nigh destitute of modified drift. The high terraces reappear below Bristol, and thence to Franklin have a height one hundred and fifty to one hundred and seventy-five feet above the river.

From Franklin to the Massachusetts line the ancient high flood-plain of the Merrimack is everywhere well shown by conspicuous terraces. Along much of the way these terraces expand

on one or both sides into wide sandy "pine plains," so called because their principal wood-growth consists of white or pitch pines. These are often accompanied by a thick and tangled undergrowth of scrub oaks, which, with the pitch pines, flourish best on these barren plains. The terraces have a very level surface, with a regular but slight slope, which amounts to nearly the same as the descent of the river.

At Franklin the upper terrace is well defined upon both sides of the valley. It has here considerable fall in a short distance, being four hundred and forty-five and four hundred and forty feet above the sea at the north side of Webster Brook and Winnipiseogee River, and descending in less than a mile to four hundred and thirty and four hundred and twenty at their south side. In the next nine miles the upper terrace falls to a height one hundred and twenty-five feet above the river, which continues for more than twenty miles to the north part of Manchester, the highest terrace seeming to descend most rapidly near the present falls of the river, so that a nearly uniform height above the river is maintained.

In Canterbury the upper terrace spreads out into plains which are at some places a mile wide. The Boston, Concord, and Montreal railroad through this town is upon these high plains, while the Northern railroad in Boscawen and Concord lies on the lowest terrace, being embanked much of the way to raise it above the floods of spring. The plains of the south part of Canterbury, extending one mile into Concord, show an unusually rapid, continuous slope, amounting to eighty feet in four miles, or from one hundred and thirty to only fifty feet above the river. The north end of this slope appears to be at the normal height, representing the level of the river at the time of deposition of these plains, while its south end is about seventy feet below this normal line, which is here shown on the west side in the plains north and south of Fisherville.

Boscawen village is built on the south end of a similarly sloping terrace, three miles long, in which distance it falls thirty feet, and we find thirty feet more fall of the same terrace in less than a mile along the village street. The whole of this terrace is below the normal height, showing a deficiency of fifteen feet at its beginning and of forty feet at the north end of Boscawen village.

The supply of alluvium brought down by the river at this point was not sufficient to fill the valley to its average depth.

The lower portions of these slopes were probably sixty feet below the surface of water, which was held back by the extensive plains brought in from the Contoocook and Soucook valleys. These plains have their greatest development on the east side of Merrimack River, extending six miles from above East Concord to the mouth of the Soucook. Their area of greatest width, which exceeds two miles, is opposite the city of Concord.

In Boscawen and Canterbury and through Concord, the lowest terrace for twelve miles occupies a wide area, of which a large part is overflowed by the high water of spring, forming the only extensive interval on this river south of Plymouth. Fine views are here afforded at the edge of the plains, whose high bluffs descend abruptly a hundred feet, overlooking the fertile intervals and the windings of the river for miles north and south.

Ancient river-beds are indicated at many places by shallow ponds, which lie in long and frequently curved depressions of the bottom-land. Horseshoe Pond is one of these, situated at the north end of Main Street, in Concord. It is shaped like a crescent, being a half mile long, nearly as wide as the present channel, and six feet above the ordinary height of the river. Its middle portion lies at the foot of a higher terrace, against which the river once swept its full current. The nearest point of the present channel is a half mile distant at the north, where the river bends and now directs its current against Sugarball Bluff, a mile and a half northeast from Horseshoe Pond. The date of these changes cannot be stated; they occurred before the first settlement here, one hundred and fifty years ago.

On the east side of the "Fan" or broad interval opposite the north part of the city of Concord, the river formerly flowed by a very circuitous route four hundred and sixty rods, which was shortened to one hundred and fifty rods by great freshets, in 1826, 1828, and 1831, cutting a direct course across two peninsulas. Ponds occupy portions of the old channel. Sugarball Bluff, one hundred and twenty-five feet in height, which forms the edge of the sand plain near this place, is now being rapidly undermined. At Davis's Bluff, a mile to the south, and of about the same height as Sugarball Bluff, a width of three rods has been swept away in as many days. Erosion at this point has continued thirty years, requiring a dwelling-house near the edge of the bluff to be several times moved and the road changed.

These recent incursions of the river upon the plains, and the ordinary changes in its channel upon the intervals, washing away

yearly from one bank and adding to the side opposite, leave no doubt that the river has flowed at the foot of the bluffs along their whole extent, occasionally making a deep excavation beyond its usual bounds, as on the east side south of Sugarball Bluff; that the high plain originally filled the whole valley; and that the river has swept many times from side to side over the space occupied by its lower terraces and interval.

Valuable beds of clay, extensively used for brick-making, occur in the highest terrace for four miles north from Hooksett upon the east side. This clay appears to form a nearly continuous stratum, which has a thickness of twenty to thirty feet, with its top about one hundred feet above the river. It is overlaid by a few feet of sand. The upper half of this stratum consists of a hard and compact *gray clay*. At a depth of ten to fifteen feet this is frequently separated by a thin layer of sand, one fourth of an inch to three inches thick, from the underlying *blue clay*, which is soft and plastic when dug from the bank. These divisions are nearly equal in amount, but in some of the brick-yards only the upper gray clay is exposed. The same gray and blue clay, the latter always below the former, are frequently found in the southeast part of New Hampshire and along Hudson River and Lake Champlain.

At Amoskeag Falls the alluvium is two miles wide, and it averages thus for three miles below, the city of Manchester lying at the middle of this distance on the east side. The greater part of this area consists of high sandy or gravelly plains, whose barrenness made this township, under its former name of Derryfield, proverbial for poverty. The falls were then utilized only as a fishing place. The river here descends fifty-six feet, and its water-power has within fifty years built up the largest city in the State.

In Merrimack and Litchfield the high sandy plains have a larger development than in any other portion of this valley, excepting Concord. On the east side the modified drift occupies almost the entire township of Litchfield. An area one fourth to three fourths of a mile wide next to the river is the fertile low terrace, which is partly interval, as opposite the mouth of Souhegan River, but lies mostly somewhat above high water. East of this is the plain, about one hundred feet above the river, having the same height as in Merrimack on the west.

The sand and gravel of the plain between Nashua River and Salmon Brook, on which the principal part of the city of Nashua

is built, appear to have been brought partly by each of these streams and partly from the northwest along the avenue followed by the Wilton railroad, where no stream now exists. A continuous belt of alluvium, upon which this railroad is built, extends six miles from the Souhegan River in Amherst to the plains near the mouth of Nashua River. Its narrowest place, three miles from the city, is a third of a mile wide, while its widest portions, in the northwest corner of Nashua and south part of Amherst, are one and a half miles wide. These plains consist of horizontally stratified sand and gravel, and show a gradual descent from northwest to southeast, amounting to seventy-five feet in the six miles.

Kames. Remarkable ridges of coarse, water-worn gravel, frequently interstratified with layers of sand, and sometimes inclosing large, angular bowlders, occur in the Merrimack Valley in Thornton, Franklin, Boscawen, and Concord; in a series twenty miles long, which extends from Loudon along Soucook River to its mouth, and thence along the west side of Merrimack River to Manchester; in Nashua and Hudson; in another series, which has been traced by Rev. George F. Wright, of Andover, extending about twenty-five miles, through Methuen, Lawrence, Andover, Wilmington, North Reading, and Reading, to Wakefield; along Brandy Brow Brook in Haverhill, and thence continuing southward in a series similar to the last; and in Newburyport.

The plains, terraces, and intervals consist of fine gravel, sand, clay, or silt, horizontally stratified; but these ridges are mainly composed of very coarse, water-worn gravel, often containing stones two or three feet in diameter. When the gravel is mixed with layers of sand, as is frequently the case in the entire section of a ridge, these materials are very irregularly bedded, portions of them dipping at a high angle, giving the whole a rudely anticlinal or arched stratification. In many of these ridges, however, a section shows no beds of sand, and almost no marks of stratification; but there is still evidence that the deposit was formed by a current of water. It contains only the smaller bowlders which would be thus separated out from the coarse glacial drift or till; these have been more or less rounded by water-wearing, being quite different from the glaciated stones of the till, while the sand and clay have been mostly swept forward by the strength of the current. Wherever the ordinary fine alluvium has been deposited it overlies or in part covers the gravel ridges, which are therefore the oldest of our modified drift deposits. Similar

ridges of gravel have been often described by European geologists, under the various names of *kames* in Scotland, *eskers* in Ireland, and *åsar* in Sweden.

In Concord these kames form the uneven east part of Blossom Hill cemetery, and extend south one and a half miles. The south end of this series is a single steep ridge twenty-five to forty feet high, called Whale's Back, which originally extended a quarter of a mile. Its north portion has been used by the city in making and repairing streets. No kame-like deposits were discovered along the east side of the river in Concord, the whole mass of the plains being fine alluvium.

Similar ridges were next found just below the mouth of Soucook River, exposed by railroad excavation on both sides of the Merrimack. The kame here cut through by this river is a portion of a series which extends twenty miles, from Loudon to Manchester. The greater part of these kames consist of very coarse, water-worn gravel, containing pebbles six inches to two feet in diameter, with no intermixture of clear sand. They are disposed in irregular ridges of southerly trend with the valley, sometimes single, but more often with irregular branches, or several are parallel to each other. Their height varies from sixty to one hundred and twenty-five feet above the river, and they are often covered, or nearly so, by the alluvium of the plains. Upon the Soucook River these kames are repeatedly cut through by its present channel, as also near its mouth by the Merrimack, but in the fourteen miles farther south they lie wholly on the west side of the Merrimack, near the edge of its alluvial area.

This series of kames and others observed along Merrimack River in New Hampshire, the single continuous kame, one hundred and fifty to two hundred feet in height, which extends twenty-four miles along Connecticut River from Lyme, N. H., to Windsor, Vt., and a notable series which extends from Saco River at Conway to Six-Mile Pond, and from Ossipee Lake southeastward along Pine River, all lie in the middle or lowest parts of the valleys, which are bordered by high ranges of hills.

The kames which we have next to consider do not follow the present water-courses, but run directly across the Merrimack and other rivers, which here have no well-marked valleys, being not much lower than the hollows between the hills on either side. Occupying these hollows, the kames extend long distances in a somewhat devious but, for the whole series, quite straight course, which is about half-way between south and southeast.

A portion of the Andover series of kames was described by Dr. Edward Hitchcock,[1] in 1842, which appears to be the earliest notice of these peculiar gravel ridges in America. He writes: "The most common and most remarkable aspect assumed by these elevations is that of a tortuous collection of ridges and rounded and even conical hills, with corresponding depressions between them. These depressions are not valleys which might have been produced by running water, but mere holes, not unfrequently occupied by a pond."

The extent of this series was at first supposed to be about one and a half miles, but Rev. George F. Wright[2] has recently traced it fully twenty-five miles, from Methuen to Wakefield. He has also traced a second parallel series, which lies about seven miles farther east, passing through Haverhill, Groveland, Georgetown, Boxford, Topsfield, and Wenham. These ridges "are ordinarily composed of sand, gravel, and pebbles, the latter from a few inches to two or three feet through, sometimes irregularly stratified, the coarse material being as likely to abound near the top as at the bottom; at other times ten or fifteen feet or more in thickness will give no sign of stratification whatever. . . . . The fragments of rock in the ridges are nearly all somewhat rounded and apparently water-worn." The first of these series is well shown in Lawrence, a short distance southeast from the water-works reservoir. On the west side of Shawshin River, opposite Andover village, it consists of three parallel kames, known as East, Indian, and West ridges, which are respectively forty, fifty, and ninety feet high. The last two inclose a bog filled with peat and mud, twenty to thirty feet deep. The base from which these measurements were taken was forty feet above Shawshin River and ninety feet above the sea.

Prominent hills, composed of unmodified drift or till, are scattered here and there along the course of the Merrimack River through Massachusetts, and in some townships are almost as thickly set as possible. These remarkable accumulations of till are readily recognized because of their smooth and regular contour. From their resemblance in shape to a lens, Prof. C. H. Hitchcock has denominated them *lenticular hills*. They are oblong or sometimes nearly round, with steep sides and smoothly rounded tops, and vary from an eighth of a mile to a half mile in length, and from forty feet to two hundred feet in height. Their

[1] Transactions of the Association of American Geologists and Naturalists.

[2] Proceedings of the Boston Society of Natural History, vol. xix., pp. 47–63.

longest axis has most frequently a northwest-southeast trend, coinciding nearly with the course of striæ on ledges throughout this part of New England. This is well seen on the north side of the Merrimack, notably in East Kingston, Kensington, and South Hampton, N. H.; but there are many exceptions on the south side of this river.

The till on the surface of these hills is comparatively loose and sandy, brownish or yellowish in color, and contains frequent bowlders up to five feet or more in diameter, many of which are angular and wholly unworn. At a depth of two or three to fifteen or twenty feet, this *upper till* is succeeded by the very compact, clayey, and dark or bluish *lower till*, which contains few large bowlders, but is thickly filled with stones up to one or two feet in diameter, nearly all of which are glaciated, having beveled or striated sides and rounded edges.

Typical examples of these drift hills are Bear Hill in Methuen; Silver's, Golden, and Great hills in Haverhill; Morse Hill in East Kingston; Moulton Ridge, Martin, and Horse hills in Kensington; Indian Ground and Chair hills in South Hampton; Whittier's Hill in Amesbury; Powow Hill in Salisbury; Prospect Hill in Andover; Hazeltine and Dead hills in Bradford; Bald Pate Hill in Georgetown; and Crane Neck and Archelaus hills in West Newbury.

Modified drift is scanty or wanting along this part of Merrimack River. The floods from which it was deposited seem to have kept their straight course and carried the most of their alluvium southward, passing over the very low water-shed between Lowell and Massachusetts Bay. A conspicuous sand terrace at Haverhill was brought down by Little River. Its steep escarpment shows that much of this deposit has been undermined by the Merrimack.

Part of the city of Newburyport is built on a broadly rounded ridge of gravel and sand, which probably had a similar origin with the narrower and steep ridges of the kames. This deposit appears first in the south part of Amesbury. It has been cut through by Merrimack River, and on its opposite side rises to a height of about one hundred and fifty feet in Moulton's Hill. A quarter of a mile farther southeast it is depressed to seventy five feet, and shows the sharp ridges and knolls of typical kames. From this point it extends with a nearly uniform height of about one hundred feet along High Street to the middle of the city, and thence continues on the southwest side of this street to the

Upper Green. Here it is interrupted for a little distance, beyond which it lies on the northeast side of this street, extending to within a half mile of Old Town Hill. The entire length of this ridge is six miles. No other high deposits of modified drift are found in this vicinity, and wide areas of lowland border it on both sides. Excavations in the northwest part of the city show the ridge there to be composed mainly of water-worn gravel, with the largest pebbles about a foot in diameter. A railroad cut, known as March's Hill, two miles farther southeast, has only occasional layers of gravel, with the largest pebbles six inches in diameter, very irregularly interstratified with sand, which is here four fifths of the whole deposit. The depth of modified drift forming this ridge is shown by wells to be from fifty to ninety feet.

At the mouth of Merrimack River a ridge of sand, twenty-five to fifty feet high and ten to forty rods wide, extends for several miles both to the north and south, facing the ocean. Marshes a mile wide, with their surface two or three feet below the highest tides, lie on the west side of this ridge. Its gentle eastern slope forms the beaches of Salisbury and Plum Island. For a quarter of a mile or more out from these beaches the water is shallow, and the waves break upon shifting banks of sand. The ridge is built up or washed away by the same cause, and is also channeled and heaped into mounds by the winds, which are constantly changing its form.

The mouth of the river has varied much during the past sixty-five years. A fort built in 1812 at the north end of Plum Island remained at one time three fourths of a mile north from the river's mouth on Salisbury Beach. Subsequent changes have brought the river back, so that now it flows out to sea at nearly the same point as in 1812.

We having now examined the recent geological records of this valley, it remains for us to seek their order and meaning. The edges of the lenticular hills of till are overlaid by the kames, and these are in turn partly covered by the alluvium of the plains and terraces. The till is, therefore, the oldest of these deposits.

This extraordinary formation, and the rounded form and striation of exposed ledges, observed in all countries where till is found, presented one of the most difficult problems of geology, which has been solved and made clear by a theory too wonderful ever to have been conjectured, were we not led to it by abundant and undeniable testimony. This theory was first brought out prominently by Agassiz in 1840, and was based upon his studies

of the glaciers in the Alps. These fields and rivers of ice, several hundred feet in depth, are found descending from the regions of perpetual snow, their rate of motion being one to five hundred feet, or even more in their steepest portions, in a year. Many angular blocks and fragments which fall from the bordering cliffs are carried along on the surface of the ice, or are contained in its mass, with others torn from the rocks over which it moves, and under its vast weight these act as graving tools to round and striate the ledges beneath. The similar striation of all northern countries and the formation of the till have been effected by a uniform cause, namely, a moving ice-sheet which overspread the continents from the north.

This continental glacier had accumulated sufficiently deep to cover every mountain summit in New Hampshire. That it overtopped Mt. Washington is fully proved by recent discoveries of Professor C. H. Hitchcock, the state geologist. Its thickness farther to the north was so much greater than in this latitude that its immense weight caused the ice to flow slowly outward, and the direction of its current in New England was to the south and southeast. By this motion fragments were torn from the ledges, and a large part of these were sooner or later held in the bottom of the ice and worn to a small size by friction upon the surface over which it moved. The resulting mixture formed beneath the ice is the ground-moraine or *lower till.* Its dark and frequently bluish color is due to seclusion from air and water during its formation, as pointed out by Torell, leaving its iron principally in the form of ferrous silicates or carbonates; and its compactness and hardness have resulted from compression under the great weight of ice. While this deposit was thus accumulating beneath the ice, great amounts of material, coarse and fine, were swept away from hill slopes and mountain sides, and afterward carried forward in the ice. When this melted a large portion of the material which it contained fell loosely upon the surface, forming an unstratified deposit of gravelly earth and bowlders, called *upper till.* It will be seen that the upper member is the one usually exposed at the surface, and it is often the only one present where only a thin covering of till is found. Its characteristics are the larger size of its bowlders, which are mostly angular and unworn; the yellowish color of its fine detritus, produced by the hydrated ferric oxide to which its iron has been changed by exposure to air and water; and the comparative looseness of its whole mass.

Frequently about Winnipiseogee Lake, and rarely elsewhere, de-

posits of stratified clay or sand are found between the lower and upper till. In these places the contour of the land seems to have prevented free drainage from the foot of the melting ice-sheet. The water then melted large open spaces beneath the ice near its margin, in which these beds of stratified drift were deposited. The overlying till was contained in the ice-sheet, and fell upon the surface when its melting was completed.

The distribution of the till in this valley is quite irregular. Sometimes no considerable accumulations of it are seen for several miles, and the ledges lie at or near the surface. Elsewhere the till occurs in large amount, covering the ledges which are scarcely exposed over some whole townships near the coast. Wherever it is found plentifully it is to a large extent massed in the peculiar lenticular hills, which, except a thin layer on the surface, are entirely composed of lower till; but we cannot explain how the ice acted to accumulate its ground-moraine over some sections in these regular hills, while over other large areas, apparently not otherwise different, they are wholly wanting.

The departure of the ice-sheet was attended with a comparatively rapid deposition of the abundant materials which it contained. It is probable that its final melting took place mostly upon the surface, so that at the last great amounts of detritus were exposed to the washing of its innumerable streams. The surface of the ice-sheet became molded by this process of destruction into great basins and valleys, and the avenues by which its melting waters escaped came gradually to coincide with the depressions of our present surface. When the glacial river entered the open area from which the ice had retreated, or in the lower part of its channel while still walled on both sides by ice, its current was slackened by the less rapid descent, causing the deposition first of its coarsest gravel, and afterwards, in succession, of its finer gravel, sand, and fine silt or clay. The valleys were thus filled with extensive and thick deposits of modified drift, which increased in depth in the same way that additions are now made to the bottom-lands or intervals of our large rivers by the annual floods of spring. The portion of the material contained in the ice-sheet which escaped this erosion of its streams formed the upper till. The abundant deposition of drift, both stratified and unstratified, during this final melting of the ice-sheet has been brought into its due prominence by Prof. James D. Dana, who denominates this the *Champlain period*, deriving the name from marine beds of this era which occur on the borders of Lake Champlain.

The oldest of our deposits of modified drift are the *kames.* From the position of these peculiar accumulations of gravel, which are overlaid by the horizontally stratified drift, the date of their formation is known to be between the period when the ice-sheet moved over the land and that closely following, in which this more recent modified drift was deposited in the open valleys from the floods that were supplied by the melting ice. We are thus led to an explanation of the kames which seems to be supported by all the facts observed in New Hampshire and Massachusetts, and which appears to apply also to the similar deposits that have been described in other parts of the United States and in Europe.

The melting of the ice-sheet over New England advanced from the sea-coast towards the north and northwest. The lowest and warmest portions of the land were probably first uncovered, and as the melted area advanced into the continental glacier its vast floods found their outlet at the head of the advancing valley. This often took place by a single channel bordered by ice-walls, as was the case along the Connecticut kame; but in the Merrimack Valley and in Eastern Massachusetts, these glacial rivers also frequently had their mouths by numerous channels, which were separated by ridges of ice. In these channels were deposited materials gathered by the streams from the melting glacier. By the low water of winter layers of sand would be formed, and by the strong currents of summer layers of gravel, often very coarse, which would be irregularly bedded, — here sand and there gravel accumulating, and, without much order, interstratified with each other. Sometimes the melting may have been so rapid that the entire section of a kame may show only the deposition of a single summer, which would then be very coarse gravel without layers of sand. When the bordering and separating ice-walls disappeared, these deposits remained in the long ridges of the kames, with steep slopes and irregularly arched stratification. Very irregular short ridges, mounds, and inclosed hollows resulted from deposition among irregular masses of ice. The *glacial rivers* which we have described appear to have flowed in channels upon the surface of the ice, and the formation of the kames took place at or near their mouths, advancing as fast as the ice-front retreated.

The extensive level *plains and high terraces* which border our rivers, constituting the most conspicuous and by far the largest portion of our modified drift, were also deposited in the Champlain period. The departing ice-sheet was the principal source

both of the vast amount of material and of water for sweeping it into the valleys, which appear in most cases to have been thus filled to the level of their highest terraces. The prevailing horizontal stratification of these deposits shows that they were spread over large areas by the current of the floods which held them in suspension. The modified drift thus increased in depth in the principal valleys through a long period, which may have continued till the last of the ice at the heads of the valley and of its tributaries had disappeared.

During the recent or *terrace period* the rivers have been at work excavating deep and wide channels in this alluvium. The terraces mark heights at which in this work of erosion they have left portions of their successive flood-plains. As soon as the supply of material became insufficient to fill the place of that excavated by the river, a deep channel was gradually formed in the broad flood-plain. This process was very slow, allowing the river to continue for a long time at nearly the same level, undermining and wearing away its bank on one side, and depositing the material on the opposite side, till a wide and nearly level lower flood-plain would be formed, bordered on both sides by steep terraces. When the current became turned to wear away the bank in the opposite direction, a large portion of this new flood-plain would be undermined and redeposited at a lower level; but the direction of the current's wear might be again reversed in season to leave a narrow strip which would then form a lower terrace. In this way the Merrimack River through New Hampshire has excavated its ancient high flood-plain of the Champlain period to a depth of seventy-five to one hundred and fifty feet, for a width varying from an eighth of a mile to one mile. In Canterbury and Concord we see the highest plain is being now undermined by the wear of the current, forming steep bluffs.

The very fine character of the materials which compose the lowest terraces and the interval or present flood-plain is due to this wearing away and redeposition by the river, which have been many times repeated, till what may have been at first gravel becomes very fine sand or silt. By each removal this alluvium is made one degree finer, and is deposited at a lower level and farther down the stream. The end of its slow journey is the ocean, where it will help to make the sedimentary rocks of this epoch. It has completed a great cycle of changes, ending where the upheaved and contorted ledges from which it was derived had their remote beginning.

ON CRITICAL PERIODS IN THE HISTORY OF THE EARTH, AND THEIR RELATION TO EVOLUTION; ON THE QUARTERNARY AS SUCH A PERIOD.[1]

BY JOSEPH LECONTE.

IN the series of rocks representing the history of the earth there occur at different horizons *unconformities.* In most cases these are not found at the same horizon in different places; but there are a few which seem to be very general. Associated with these unconformities, as is well known, there is nearly always a marked change in the fossil species. The greatness of this change is invariably in direct proportion to the generality of the unconformity. These general unconformities attended with very great changes in organic forms are the natural boundaries of the great divisions of time, and the less general unconformities attended with less sweeping change of organic forms, of the subdivisions of time.

The earlier geologists, under the influence of the *then* dominant idea of frequent supernatural interference with the course of nature, imagined that these unconformities marked the times of instantaneous cataclysm which disturbed the rocks and destroyed all living things, sometimes locally, sometimes generally, and that these exterminations were followed by re-creations of other and wholly different species at the beginning of the subsequent period of tranquillity. *Now,* however, we believe that no such instantaneous general exterminations and re-creations ever occurred. We know that unconformity simply indicates eroded land-surface, and therefore marks a period of time during which the observed place was land and received no sediment; that two series of rocks unconformable to each other denote two periods of comparative quiet, during which the observed place was sea-bottom, receiving sediment steadily, separated by a period of oscillation producing increase and decrease of land, during which the observed place was raised into land-surface, with or without crumpling of the strata, deeply eroded, and then sunk again below sea level to receive the second series of strata. The length of the two periods of repose is roughly measured by the thickness of the two conformable series. The length of the period of commotion is roughly measured by the amount of erosion at the line of unconformity.

[1] Read before the National Academy of Sciences, April 18, 1877. (Reprinted from the American Journal of Science and Arts, for August, 1877.)

Evidently, therefore, every case of unconformity marks a period of time — often a long period — during which there was no record made in strata and fossils at the observed place; certain leaves — frequently very many — are there missing from the Book of Time. Is it any wonder, then, that skipping over these pages when we commence reading again we find the matter entirely new? Evidently, the suddenness of the change in organic forms is only apparent. If we could recover the record, which was doubtless carried on elsewhere, the break would disappear; if we could find the missing leaves the reading would be continuous. In every such instance, therefore, there is a *lost interval* of history. In cases of local unconformity we recover the lost record in other places, and thus fill up the blank in the history. But in some cases of very general unconformity, such as those which mark the great divisions of time, the loss is not yet recovered, perhaps is irrecoverable, though doubtless the more complete knowledge of the geology of the whole earth surface will go far toward filling blanks and making the record continuous.

The view above presented is now held by all geologists, but there seems to be danger, under the influence of the *now* dominant views of evolution, of erring on the other extreme. Assuming a *uniform rate* of evolution, many, it seems to me, commit the mistake of measuring the amount of lost interval by the amount of change of organic forms, and thus discredit the real value of the geological record by exaggerating greatly its fragmentary character. On the contrary, there appears good reason to believe that the evolution of the organic kingdom, like the evolution of society and even of the individual, has its periods of *rapid movement* and its intervals of *comparative repose* and readjustment of equilibrium. Geological history, like all other history, has its periods of comparative quiet, during which the forces of change are gathering strength, and periods of revolution, during which the accumulated forces manifest themselves in conspicuous changes in physical geography and climate, and therefore in rapid movement in the march of evolution of organic forms, — periods when the forces of change are *potential*, and periods when they become *active*. Conformable rocks represent the intervals of comparative quiet, during which organic forms are either permanent or change slowly; unconformity represents a time of oscillation, with increase and decrease of land, and therefore of rapid changes of physical conditions and correspondingly rapid movement in evolution. The general unconformities, of

course, mark times of very general commotion, — of wide-spread changes of physical geography and climate, and consequently of exceptionally rapid and profound changes in organic forms.

These periods of revolution in all history are *critical*, and hence are of especial interest to the philosophic historian and to the evolutionist; but they are also in all history periods of *lost record*. And as in human so also in geological history, — the farther back we go the longer are the lost intervals and the more irrecoverable the lost records. We will now give examples of such lost intervals, and show their significance in evolution.

The first and by far the greatest of these is that which occurs between the Archæan and the Palæozoic. In every part of the earth where the contact has yet been observed the Primordial lies unconformably on the upturned and eroded edges of the Archæan strata. This relation was observed first in Canada, then in various parts of the Eastern United States, then in Scotland, the Hebrides, Bavaria, Bohemia, Scandinavia. Unconformity in such widely separated localities indicates wide-spread changes in physical geography, and therefore, presumably, of all those physical conditions included in the word *climate*. These changes of physical geography are best illustrated in the United States. The break between the Archæan and the Primordial has been observed in very many places all over the wide area of the United States, east and west: not only in Canada, in New York, in the Appalachian region, in Wisconsin, Missouri, Arkansas, and Texas, but also all over the Rocky Mountain region, in Nebraska, Montana, Idaho, Wyoming, Colorado, Utah, Nevada, New Mexico, and Arizona. As upturned, eroded, outcropping strata mean land surface, it is evident that there was at that time *a very large area or else several large areas of land* in the place now occupied by the American continent. In comparison with the subsequent Silurian it was *a continental period.* This land is often spoken of as *Archæan land.* It was indeed land of *Archæan rocks*, but for that very reason not of Archæan times, for these rocks were, of course, formed at the bottom of the sea in Archæan times, and therefore these localities were all sea-bed receiving sediment at that time. We know absolutely nothing of the land of Archæan times, and never can know anything until we find still older rocks, from the *débris* of which Archæan sediment was formed. The land spoken of above was *land of the Lost Interval.* That the interval was immensely long is evident from the prodigious erosion. That it was a period of wide-

spread oscillation is also apparent, for all the places mentioned were sea-bed in Archæan, land during the interval, and again sea-bed during the Silurian. But of this long interval not a leaf of record remains.

Evidently, then, at the end of the Archæan an enormous area of Archæan sea bottom was raised up and crumpled, and became land. After remaining land for a time sufficiently long to allow enormous erosion of crumpled strata it again went down to the old Primordial shore line, and the Silurian age commenced. This time of elevation is the lost interval.

Now, when the record closed in the Archæan, as far as we know, only the lowest forms of Protozoan life yet existed. The beginnings of life had not yet differentiated into what might be called a fauna and flora. When the record again opened with the Primordial we had already a varied and highly organized fauna, consisting of representatives of many classes and of all the great types of animal structure except vertebrates. Nor were these representatives the lowest in three several departments, for Trilobites and Orthoceratites can hardly be regarded as lower than the *middle of the animal scale* as it now exists. It is certain, therefore, that all the great departments except vertebrates, and most of the classes of these departments, including animals at least half-way up the animal scale, were differentiated during the lost interval. The amount of evolution during this interval cannot be estimated as less than all that has subsequently taken place. Measured by the amount of evolution, this lost interval is equal to all the history of the earth which has since elapsed. We escape this very improbable conclusion only by admitting *a more rapid rate of evolution during critical periods.*

It is one of the chief glories of American geology to have first established the Archæan as one of the primary divisions of time. It is even yet reluctantly admitted as such by many European geologists. And yet it is seen that from every point of view, whether of the rock system or of the life system, it is by far the most widely and trenchantly separated of all the eras.

The next greatest lost interval (though far less than the preceding) is that between the Palæozoic and the Mesozoic. Here we have the next most general unconformity, indicating the next most wide-spread changes of physical geography and climate, accompanied by the most sweeping changes in organic forms, not only in species and genera, but also in families and orders. This change is the more striking as it occurs in the midst of an abun-

dant life. It is the greatest and most general change in the forms of organisms which has ever occurred in the history of the earth. *It took place, again, during a lost interval.* A portion of the loss is recovered in the Permian, but the most critical time, the time of most rapid change, namely, that between the Permian and the Trias, is still missing. How we long to find the steps of this great change! What a flood of light would it shed on the process of evolution! But although the change in the organic kingdom was, just here, so enormously great, yet the lost interval does not seem very long, for in England the Trias and Permian seem to be conformable, though probably with change from marine to fresh-water conditions. It is hence impossible to resist the conclusion that the steps were just here fewer and longer and the progress more rapid than usual. As in human history, revolutions are the times of the birth of new social ideas, upon which, during the subsequent period of tranquillity, society is readjusted in prosperity and happiness on a higher plane, so also in geological history, critical periods are times of origin of new and higher organic forms, and the subsequent periods of tranquillity are times of readjustment of equilibrium and prosperous development of these forms.

Like the previous lost interval, this was also a period of oscillation,—a period of great increase of land, which was again partly submerged to inaugurate the Trias. It was, therefore, also *a continental period.* The land-making commenced at the end of the Coal period, in this country with the formation of the Appalachian Mountains, continued through the Permian, and culminated in the lost interval, which is, in fact, for that very reason lost.

Far less in length of time and perhaps in the sweeping character of the change of organisms, but far more important and interesting on account of the high position of the animals involved, is the lost interval between the Mesozoic and Cænozoic. The length of time lost here is comparatively small. In America, in many parts of the West, the uppermost Cretaceous seems to pass into the lowermost Tertiary without the slightest break of continuity. There may be some break, some unconformity, some lost record, but certainly it cannot be large. Yet the change, especially in the higher animals, is immense. In America the break and the lost interval is much greater between the Jurassic and Cretaceous than between the Cretaceous and Tertiary, still the organic change is far greater in the latter case. The reason is that the

changes of physical geography and climate in the latter were *more general.* Although in America the break and the lost interval is greater at the end of the Jurassic, yet, taking the strata all over the earth, the break is far more general at the end of the Cretaceous; and it is these *general* changes in physical geography which affect climate the most, and which, therefore, produce the profoundest changes in organic forms.

Now it is almost impossible to imagine a clearer proof of the fact of rapid evolution-movement during critical periods than we find in the shortness of the lost interval and the greatness of the change in higher organisms just at this horizon in the rocky series. Nothing can be more astonishing than the abundance, variety, and prodigious size of reptiles in America up to the very close of the Cretaceous, and the complete absence of all the grander and more characteristic forms in the lowest Tertiary, unless, indeed, it be the correlative fact of complete absence of mammals in the Cretaceous, and their appearance in great numbers and variety in the lowest Tertiary. If Cretaceous mammals existed in *America*, surely their remains would have been found in the wonderfully rich Cretaceous strata. It seems certain that in America, or at least in that portion which has been examined, mammals appeared somewhat suddenly and in great numbers on the scene, and were a principal agent in the extermination of the large reptiles. The wave of reptilian evolution had just risen to its crest, and perhaps was ready to break, when it was met and overwhelmed by the rising wave of mammalian evolution.

We have dwelt only on the great change in the higher classes, but the change really extended to all classes. This was, therefore, a time of exceptionally general and rapid changes in all departments alike. In other words it was a critical period in organic evolution.

That it was also a time of very extensive changes in physical geography here in America, as well as elsewhere, is well known. The Cretaceous sea, which extended from the Gulf of Mexico to the Arctic Ocean, covering the whole western plains and plateau region, and thus dividing the American continent into two, — an eastern Appalachian continent and a western or basin region continent, — was abolished at the end of the Cretaceous, and replaced by great fresh-water lakes in the same region, and the continents became one. Moreover, it is probable that it was a period of wide-spread oscillation, that is, of upheaval and again of subsidence to the condition of things found at the beginning of

the Tertiary. It is probable that the upheaval which destroyed the Cretaceous sea went much beyond the condition of things afterwards; that just at this interval the land was higher and larger than in the Tertiary; that, in short, this was again a *continental period*, and probably a period of greater cold than the subsequent Tertiary.

The change in physical geography, then, was immense, but in most places by bodily upheaval, not by crumpling of the strata; and therefore the usual sign of such change, namely, unconformity, is often wanting. The change of climate all over the American continent was no doubt very great, and the change in organic forms correspondingly great everywhere and in all departments; but this was especially true of all water-inhabiting species in the region of the old Cretaceous interior sea, for here there was a transition, not only in climate but from salt to fresh water through the intermediate condition of brackish water. The Cretaceous marine species rapidly disappeared, partly by extermination and partly by transmutation into fresh-water species, as has been observed, recently, to take place in some crustaceans under this change of conditions.[1] The Tertiary fresh-water species quickly appeared, partly by transmutation from the previous marine species and partly by transportation in various ways from other fresh-water lakes. But all this occurred in some places without the slightest break in the continuity of the strata.

The great change of climate and other physical conditions perhaps sufficiently explain the change in *invertebrate* species, but it is impossible to account for the somewhat sudden appearance of mammals in the lowest Tertiary, except by *migration* from other regions where they had existed in late Cretaceous times, having originated there by derivation in the usual way. That marsupials existed somewhere in Cretaceous times (though possibly not in America or Europe) there can be no doubt; for they lived, we know, in the preceding Jurassic and the following Tertiary, and they exist *now*. It is from these rather than from Cretaceous reptiles that Tertiary mammals were doubtless derived; and this derivation took place probably at rapid rate in the latest Cretaceous or during the lost interval, in some unknown locality, whence they migrated into the Tertiary lake region of the United States during the interval. This migration came most probably from Northern Asia, for it must be remembered that

[1] Arch. des Sciences, November, 1875, p. 284.

the interval was a continental period, and therefore probably a period of broad land connections between Nearctic and Palæarctic regions. The complete examination of the uppermost Cretaceous of different portions of Asia will probably reveal the immediate progenitors of the early Tertiary mammals of Europe and America. This introduces us to a most important element of rapid local faunal change, especially in higher animals, namely, *migrations*. If we do not dwell longer now on this, it is only because we shall have to recur to it again.

I have preferred, thus far, to speak of *general* evolution-changes of organisms, whether slow or rapid, as produced by varying pressure of external conditions, and of the most striking *local* changes by migrations from other regions, where the apparently suddenly-appearing species had previously existed, having originated there by evolution in the usual way. I have chosen, thus far, to represent the organic kingdom as lying, as it were, *passive* and plastic under the molding hands of the environment. I have done so because it is in accordance with true method to exhaust the more obvious causes of evolution before appealing to the more obscure and doubtful.

It is possible that general movements affecting alike all classes may be accounted for in this way alone. But there are many facts in the evolution of the organic kingdom, especially the sudden appearance of new forms in the quietest times, which can hardly be thus explained. There seem to be *internal* as well as *external* factors of evolution. Again, the internal factors may be either in the form of *tendencies* to change or of *resistance* to change. Of these, however, the latter seems to be most certain. There may be in the organic kingdom an "*inherent tendency*" to change in special directions, similar to that which directs the course of embryonic evolution, — a tendency, in the case of the organic kingdom, inherited from physical nature from which it sprang, as in the case of the embryo it is inherited from the organic kingdom through the line of ancestry. This cause, however, is too obscure, and I therefore pass it by.

But whether or not there be any such inherent tendency to change, there certainly is an inherent tendency to *stability*, — to persistence of organic form. If there be no inherent force of progress, there certainly is an inherent force of *conservation* greater in some species than in others. It seems probable that in many of the more rigid types this stability is so great, and therefore variation of offspring so slight, that progressive change of

form is too slow to keep pace with change of external conditions, especially in critical periods. If this be so, then an organism may be regarded as under the influence of two opposing forces: the one conservative, the other progressive; the one tending to equilibrium, the other to motion; the one to permanence, the other to change of form; the one static, the other dynamic; the one internal, *the law of heredity*, the other external, the *pressure of a changing environment.* Under the influence of two such forces, the one urging, the other resisting, it is evident that even with steady changes of external conditions the change of organic forms would be more or less paroxysmal. Other kinds of evolution, physical and social, evidently advance paroxysmally from this cause. As, therefore, in the gradual evolution of earth-features there are periods of comparative quiet, during which the forces of change are gathering strength but produce little visible effect, being resisted by crust-rigidity, and periods when the accumulating forces finally overcome resistance and determine comparatively rapid changes; as in social evolution there are periods in which forces of social change are gathering strength but make no visible sign, being resisted by social conservatism, — rigidity of the social crust, — and periods in which resistance gives way and rapid changes occur, so also in the evolution of the organic kingdom the forces of change, that is, pressure of changing environment, may accumulate but make little impression, being resisted by the *law of heredity* — of *like producing like* — or type-rigidity, until, finally, the resistance giving way, the organic form breaks into fantastic *sports* which are at once seized by natural selection, and rapid change is the result.

Some persons seem to think that paroxysmal evolution is inconsistent with the uniformity of nature's laws. On the contrary, it is in perfect accord. Laws and forces are indeed uniform, but phenomena are nearly always paroxysmal. The forces of volcanoes and earthquakes, of lightning and tempests, are uniform, but the phenomena are paroxysmal. Winds at the earth's surface, where the resistance is great, *blow in puffs.* A thin sheet of water over a smooth sloping surface *runs in waves.* The law may be illustrated in a thousand ways. In all cases where an accumulating force is opposed by a constant resistance, we have phenomena in paroxysms.

But whatever be the cause, the *fact* of paroxysmal movement of organic evolution is undoubted. All along the course of geological history, from beginning to end, even when the times were

quietest, where the record is fullest and apparently without any missing leaf, species come and go and others take their place, and yet only rarely do we find any transition steps. If this were merely once or twice or thrice, or to any extent exceptional, it might be explained by loss of record here and there, but it occurs thousands and tens of thousands of times. Now, if evolution moves only at uniform rate, if it takes one hundred thousand years to transmute one species into another (as it certainly does when evolution is moving at its usual rate), if there are at least one hundred thousand steps (represented each, of course, by a whole generation of many individuals) between every two consecutive species, it is simply incredible that all the individuals representing the intermediate steps, so infinitely more numerous than the species they connect, should be so generally, almost universally, lost. But the phenomena, as we find them, are easily understood if a few generations represent the transition step, and many generations the permanent form.

A similar rapid, almost sudden, appearance and extinction of *genera*, *families*, and higher groups at certain horizons are also common. In these cases the intermediate steps of transition are often found, and constitute, in fact, the chief demonstrative evidence of the truth of evolution. But the difficulty on the assumption of a uniform rate of evolution is none the less here, for the time required to evolve a new genus or a new family is, of course, immensely greater than in the case of a new species.

We will illustrate the difficulties of the ordinary view by one striking example. In the Upper Silurian, in the midst of a conformable series, — where if there be any break, any lost record, surely it must be very small, — appear suddenly, without premonition, *fishes*; not a connecting link between fishes and any form of invertebrates, but perfect, unmistakable fishes. Here we have, therefore, the appearance not only of a new class, but of a new sub-kingdom or type of structure, *Vertebrata*. Now, to change from any previously existing form of invertebrate, whether worm, crustacean, or mollusk, into a vertebrate, by a series of imperceptible steps represented by successive generations, — steps so imperceptible that it would take one hundred thousand of them to advance from one intermediate species to another, — would require an amount of time which is inconceivable to the human mind, and a number of steps, each be it remembered, represented by thousands of individuals, which can scarcely be expressed by figures. And yet we must believe that these innumerable tran-

sitional forms, each represented by innumerable individuals, are all lost, and that this prodigious time shows no evidence in the rocky record. If this case were exceptional we might possibly admit that fishes appeared in Great Britain by migration (as they probably did), but only after having previously existed untold millions of ages somewhere else; but similar cases are too common to be explained in this way.

Now the whole difficulty disappears, — we avoid the incredible imperfection of the geological record (imperfect at best); we avoid also the necessity of extending geological time to a degree which cannot be accepted by the physicist, — if we admit that the derivation of one species from another is not necessarily by innumerable imperceptible steps, but may sometimes be by a *few decided steps;* and that the same is true for the origin of new genera, families, orders, etc.; in a word, that there are in the history of evolution of species genera, families, orders, etc., and of the organic kingdom *periods of rapid movement.* When the whole organic kingdom is involved in the movement, then we call the period *critical*, and the record of it is often lost.

Thus, on the supposition of such rigidity or resistance to change in organic forms, varying in degree in different species and in different genera, families, orders, etc., a rigidity, also, *increasing by accumulated heredity so long as conditions remain unchanged*, it is evident that, in times of perfect tranquillity all species grow more and more rigid. In times of very gradual change the more plastic species change gradually *pari passu*, while the more rigid species change paroxysmally, now one, now another, as their resistance is overcome. Finally, in times of revolution nearly all forms yield to the pressure of external conditions and change rapidly, *only the very exceptionally rigid being able to pass over the interval to the next period of readjusted equilibrium.*

Thus, for example, the great and wide-spread changes of physical geography which occurred at the end of the Carboniferous, appropriately called in this country the *Appalachian revolution*, were the death-sentence of the long-continuing and therefore rigid Palæozoic types. But the sentence was not immediately executed. The Permian represents the time between the sentence and the execution, — the time during which the more rigid Palæozoic forms continued to linger out a painful existence in spite of changed and still changing conditions. But the most critical time — the time of most rapid change, the time of actual execution — was the *lost interval.* Only a very few most rigid forms pass over this interval into the Trias.

The Quaternary, a Critical Period. We have given examples of several general unconformities, the signs of wide-spread oscillations of the earth-crust, attended with increase and decrease of land, and therefore with great and wide-spread changes of climate and other physical conditions, and also with great and rapid changes of organic species. These times of general oscillation are therefore the natural boundaries of the Eras or primary divisions of Time. We have called them critical periods, transition periods, periods of revolution, because they are times of rapid change, both in the physical and the organic world,—a change overthrowing an *old* and establishing a *new* order of things. They are also times of *lost record.* We have seen that these critical periods, in comparison with the préceding and succeeding, are *continental periods,* and it is for this reason that their record is usually lost.

Now, the Quaternary is such a critical or transition period, marking the boundary between two great eras. The Quarternary is also a period of great and wide-spread oscillations, with increase and decrease of land,—a period of upheaval, erosion, down-sinking, to rise again slowly to the present condition. The early Quaternary was, therefore, to a marked degree a continental period. Here also we have newer rocks lying unconformably on the eroded edges of an older series—river sediments in old river-valleys, marine sediments in fiords; in other words, we have unconformity on a grand scale. Also, in connection with these oscillations, we have great changes in physical geography, and corresponding and very wide-spread changes in climate, and consequently corresponding rapid changes in organic forms. Here, then, we have all the characteristics of one of the boundaries between the primary divisions of time. We have a transition or *critical* period,—a period corresponding to one of the lost intervals; only in this instance, being so recent and being also less violent than the preceding ones, *it is not lost.* From this it follows that the study of the Quaternary ought to furnish the key which will unlock many of the mysteries which now trouble us. Some of the problems which have been or will be explained by study of the Quaternary we will now briefly mention.

I. *Changes of Species not sudden.* If the Quaternary were lost, and we compare the Tertiary rocks with the unconformably overlying recent rocks, and the Tertiary mammals with those now living, how great and apparently sudden seems the change!

How like to a violent extermination and re-creation! But the Quaternary is fortunately not lost, and we see that there has been no such wholesale extermination and re-creation, but only gradual though comparatively rapid transition.

II. *Migration One Chief Cause of Change.* But what is still more important, we are able to trace with something like certainty the cause of these rapid changes, and we find that in the higher animals, chief among these causes have been *migrations*, — migrations enforced by changes of climate, and migrations permitted by changes of physical geography opening gateways between regions previously separated by impassable barriers. This point is so important that we must dwell upon it. Only an outline, however, of some of these migrations and their effects on evolution can be given in the present condition of knowledge.

During Miocene times, as is well known, evergreens, allied to those now inhabiting Southern Europe, covered the whole of Europe as far north as Lapland and Spitzbergen. In America, Magnolias, Taxodiums, Libocedrus, and Sequoias very similar to, if not identical with, those now living on the Southern Atlantic and Gulf coasts and in California were abundant in Greenland. Evidently there could have been no *Polar ice-cap* at that time, and consequently no arctic species unless on mountain tops. During the latter part of the Pliocene the temperature did not differ much from the present; the Polar ice-cap had therefore commenced to form, with its accompaniment of arctic species. With the coming on of the *Glacial epoch*, the polar ice and arctic conditions crept slowly southward, pushing arctic species to Middle Europe and Middle United States, and sub-arctic species to the shores of the Mediterranean and the Gulf. With the return of more genial climate, arctic conditions went slowly northward again, and with them went arctic species slowly migrating, generation after generation, to their present arctic home.

Similarly, molluscous shells migrated slowly southward and again northward to their present position. But *plants* and some terrestrial invertebrates, such as *insects*, had an alternative which shells had not, namely, that of seeking arctic conditions also *upward* on the tops of mountains. Many did so, and were left stranded there until now. It is in this way that we account for the otherwise inexplicable fact that Alpine species in Middle Europe are similar or even largely identical with those in the United States, and also with those now living in arctic regions. These species were wide-spread all over Europe and the United

States in Glacial times; and while some of them afterward went northward to their present home, some in each country sought arctic conditions in Alpine isolation. This explanation, which has been long recognized for plants, has been recently applied by Mr. Grote to arctic insects found on the top of Mt. Washington and the mountains of Colorado.[1]

Undoubtedly changes of climate during this time enforced similar migrations among mammals also. But it is evident that while plants and invertebrates might endure such modifications of climate and such enforced migrations with little alteration of form, the more highly organized and sensitive mammalian species must be either destroyed or else must undergo more profound changes. Moreover, the opening of land connections between regions previously isolated by barriers would be far more quickly taken advantage of by mammals than by invertebrates and plants. The migrations of plants are of necessity very slow, that is, from generation to generation. The migrations of mammals, too, so far as they are *enforced* by changing climate, are of a similar kind; but the voluntary migrations of mammals, *permitted* by removal of barriers, may take place much more rapidly, even in a few generations. This introduces another element of very rapid local change, namely, the *invasion* of one fauna by another equally well adapted to the environment, and the struggle for life between the invaders and the autochthones.

For example: in America during the Glacial epoch, coincidently with the rigorous climate, there was an elevation of the continent, greatest in regions of high latitude, but also probably great along the line of the Mississippi River; for in this region it extended southward even to and beyond the shores of the Gulf. Professor Hilgard has shown that the elevation at the mouth of the Mississippi River was at least four hundred and fifty to five hundred feet above the present condition. Until the Glacial times the two Americas were certainly separated by sea in the region of the Isthmus, as shown by the Tertiary deposits there. This barrier was removed by upheaval during the Glacial epoch, and a far broader connection existed *then* than now. Through this open gate-way came the fauna of South America, especially the great Edentates, into North America. Similarly a broad connection then existed between America and Asia in the

[1] This application, with reference to Mt. Washington and other arctic insects in America, was previously made by Prof. A. S. Packard, Jr., in the Memoirs of the Boston Soc. Nat. Hist., i. p. 256. 1867. — EDS.

regions of the shallow sea between the Aleutian Isles and Behring Strait. Through this gate-way came an invasion from Asia, including probably the mammoth. With this invasion probably came also man. It seems probable, therefore, that the earliest remains of man in America will be found on the Pacific coast.

Also the great Pliocene lake, which stretched from near the shores of the Gulf far into British America, and possibly into arctic regions, and formed a more or less complete barrier to the mammalian fauna east and west, *was abolished* by upheaval, and free communication was established. It is impossible that all these changes of climate and all these migrations, partly enforced by changes of climate and partly permitted by removal of barriers, and in this latter case especially attended with the fiercest struggle for life, should not produce rapid and profound changes in the mammalian fauna.

In Europe the process has been more accurately studied and is better known. In Quaternary times at least four different mammalian faunæ struggled for mastery on European soil. (1.) The Pliocene autochthones. (2.) Invasions from Africa by opening of gate-ways through the Mediterranean: one by way of Italy, Sicily, and Malta, and one by Gibraltar, both of which have been again closed. (3.) Invasions from Asia, by removal of a great sea barrier connecting the Black and Caspian seas with the Arctic Ocean. This gate-way has remained open ever since. (4.) Invasions from arctic regions, enforced by changes of climate. Probably more than one such invasion took place; certainly, one occurred during the second Glacial epoch. The final result of all these climatic changes and these struggles for mastery was that the Pliocene autocthones, adapted to a more genial climate, were mostly destroyed or else driven southward with some change into Africa: the African invaders were driven back also into Africa, and with some Pliocene autocthones isolated there by subsidence in the Mediterranean region closing the southern gateways, and still exist there under slightly modified forms; the Arctic invaders were again driven northward by return of more genial climate, and there exist to this day; while the Asiatics remained masters of the field, though greatly modified by the conflict. Or perhaps, more accurately, we might say that the existing European mammalian fauna is a resultant of all these factors, but the controlling factor is the Asiatic. With the Asiatic invasion came man, and was a prime agent in determining the final result.

Thus, regarding the Tertiary and the Present as consecutive eras, and the Quaternary as the transition or critical period between, then, if the record of this period had been lost, corresponding with the unconformity here found, we should have had here an enormous and apparently sudden change of mammalian species. Yet this change of fauna, as great as it is, is not to be compared with that which occurred between the Archæan and Palæozoic, or between the Palæozoic and Mesozoic, or even that between the Mesozoic and Cænozoic; for the change during the Quaternary is mostly confined to species of the higher mammals, while the change during previous critical periods extended to species of all grades, and not only to species, but to genera, families, and even orders. We conclude, therefore, that *the previous critical periods or lost intervals were far longer than the whole Quaternary; or else that the rate of evolution was far more rapid in these earlier times.*

To sum up, then, in a few words, the general formal laws of evolution-change throughout the whole history of the earth: —

(1.) Gradual, very slow changes of form everywhere under the influence of all the factors of change, known and unknown: for example, pressure of changing physical conditions whether *modifying the individual* (certainly one factor), or *selecting the fittest offspring* (certainly another factor); improvement of organs by use and the improvement inherited (certainly a third factor), and perhaps still other factors yet unknown. This general evolution by itself considered would produce similar changes everywhere, and therefore would produce geological faunæ, but not geographical diversity. Determination of a geological horizon would in this case be easy, because fossil species would be everywhere identical.

(2.) Changes in different places and under different physical conditions, taking different directions and advancing at different rates, give rise to *geographical faunæ.* This, if there were nothing more, would produce far greater geographical diversity and more complete localization of faunæ and floræ than now exists, — so great that the determination of a geological horizon would be impossible.

(3.) The force of change resisted by heredity, in some species and genera more than in others, determines paroxysms of more rapid movement of general evolution, affecting sometimes species, sometimes genera or families. The sudden appearance of species, genera, families, etc., in quiet times is thus accounted for.

(4.) *During critical periods*, oscillations of the crust, with rapid changes of physical geography and climate, determine a more rapid rate of change in all forms: first, by *greater pressure of physical conditions;* and, second, by *migrations* partly enforced by the changes of climate and partly permitted by removal of barriers, and the consequent *invasion* of one fauna and flora by another and *severe struggle* for mastery. This would tend to *equalize again* the extreme diversity caused by the second law; but the effect would be more marked in the case of animals than plants, because voluntary migrations are possible only in this kingdom. Hence it follows that *a geological horizon is far better determined by the fauna than by the flora.*

III. *Historic Value of the Present Time.* Most geologists regard the Present as one of the minor subdivisions of the Cænozoic era, or even of the Quaternary period. More commonly the Quaternary and Present are united as one age — the age of man — of the Cænozoic era. The Cænozoic is thus divided into two ages: the age of mammals commencing with the Tertiary, and the age of man commencing with the Quaternary; and the Quaternary subdivided into several epochs, the last of which is the Present or Recent. But if the views above expressed in regard to critical periods be correct, then the Present ought not to be connected with the Quaternary as one age, nor even with the Cænozoic as one era, but is itself justly entitled to rank as one of the *primary divisions* of time, as one of the great eras separated like all the other eras by a critical period; less distinct it may be, at least as yet, in species than the others, the inaugurating change less profound, the interval less long, but dignified by the appearance of man as the dominant agent of change, and therefore well entitled to the name *Psychozoic* sometimes given it. The geological importance of the appearance of man is not due only or chiefly to his transcendent dignity, but to his importance as an agent which has already very greatly, and must hereafter still more profoundly, modify the whole fauna and flora of the earth. It is true that man first appeared in the Quaternary, but he had not yet established his supremacy; he was still fighting for mastery. With the establishment of his supremacy the reign of man commenced. An age is properly characterized by the *culmination*, not the first appearance, of a dominant class. As fishes existed before the age of fishes, reptiles before the age of reptiles, and mammals before the age of mammals, so man also appeared before the age of man.

We therefore regard the Cænozoic and Psychozoic as two consecutive eras, and the Quaternary as the critical, revolutionary, or transitional period between. But since the record of this last critical period is not lost, and we must place it somewhere, it seems best to place it with the Cænozoic era and the mammalian age, and to commence the Psychozoic era and age of man with the completed supremacy of man, that is, with the Present epoch.

BERKELEY, CALIFORNIA, *March* 15, 1877.

RECENT LITERATURE.

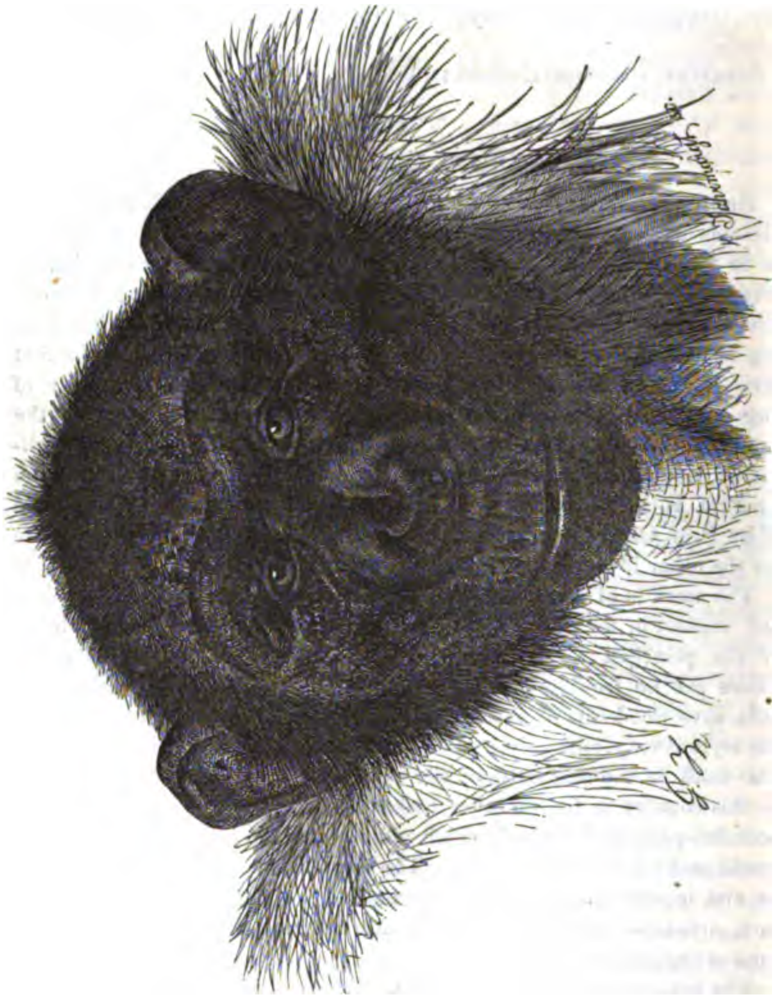
BREHM'S ANIMAL LIFE.[1] — A second edition of Brehm's well-known German work on the animal kingdom is now in course of publication, to be issued in about a hundred parts, published weekly or fortnightly, forming a series of volumes of unusual attractiveness and interest. The author tells us that it is really a new work under an old title, having been rewritten and enlarged. While the first volume of the first series treats of the mammals from the apes down to the family of dogs, succeeding volumes will treat of the other mammals and of the reptiles and fishes. These will be written by Dr. A. E. Brehm, the well-known naturalist, while those on the articulated animals will be written by Prof. E. L. Taschenberg, of Halle, and the mollusks will be treated of by Prof. Oscar Schmidt, of Strasburg. What provision is to be made for the other invertebrate animals is not yet announced.

The work is of a general nature, not designed for the special zoölogical student or for children, but for those who wish to gain a knowledge of the principal forms of animal life, their habits and distribution. There are no troublesome, perplexing anatomical or embryological details, save wood-cuts of skeletons, in word or picture, no foot-notes, and the style is easy, sprightly, and often colloquial. It is apparently a popular work in the best sense of the word, and should be well patronized in this country, if for no other reason than for the wealth of wood-cuts, both full-page and textual, which alone, to those ignorant of German, would make it of lasting value. The illustrations are nearly all new to us, and in very many, we suppose most, cases are drawn from life by such artists as R. Kretschmer, G. Mutzel, and E. Schmidt, with the greatest apparent fidelity.

The plan of the work is excellent. After an introductory chapter on life in its totality, the apes are described, — man, the type of the first suborder of Primates, being referred to only incidentally in comparison with

[1] *Brehm's Thierleben.* Allgemeine Kund, des Thierreichs. Grosse Ausgabe. Zweite umgearbeitete und vermehrte Auflage. Erste Abtheilung, Säugethiere. Erster Band. Leipzig Verlag des bibliographischen Institute. 1876. 8vo, pp. 706. New York: B. Westermann & Co. 40 cents a part; 12 parts to a volume.

the apes, which represent the second suborder of Primates. Then follows a general "popular" account of the forms of apes, their geographical distribution, dwelling-places, food, motions, social life, language, reproduction, education, rearing of young, diseases, life in confinement, and of the apes figured on the Egyptian temples; then succeeds a more special account of the gorilla, the chimpanzee, and the tschego (*Anthropopi-*



(Fig. 59.) TSCHEGO APE.

thecus tschego), and orang, with the lower forms. In this comprehensive and, we may readily believe from the high reputation of the author, thorough manner, the different groups of animals are treated. A sample of the elaborate nature of the wood-cuts is afforded in the two accompanying views of the head of a five-year old tschego in the Dresden Zoological Garden, which was brought from the Loango coast.

As an indication of the abundance of illustrations in the first volume it may be stated that there are nineteen full-page pictures of animals, grouped from studies after nature; fifty-two finished cuts in the text of apes and monkeys; twelve of bats; twenty-eight of cats; and thirty-eight of dogs. A volume on insects has appeared, and the second volume on mammals is now in course of publication.

(FIG. 96.) TSCHEGO APE, PROFILE.

UNITED STATES COMMISSION OF FISH AND FISHERIES.[1] — From a comparatively small beginning the United States Commission of Fish and Fisheries has, by its practical results in pisciculture, assumed so much importance that Congress last spring appropriated fifty thousand dollars for the work of 1877. It is understood that this appropriation is to be devoted solely to the raising of fish, and not for any purely scientific investigations, although by the excellent economical management of Professor Baird and his assistants in past years a great deal has been

[1] *United States Commission of Fish and Fisheries.* Part III. Report of the Commissioner for 1873–74 and 1874–75. Washington. 1876. 8vo, pp. 777.

done, by their gratuitous labors, to extend the knowledge of such marine and fresh-water animals of the United States as form the food of fishes. The present report is wholly practical in its nature, comprising an inquiry into the decrease of the food fishes, and the propagation of food fishes in the waters of the United States. Appended to the report are essays, mostly taken from foreign sources, on fisheries and fish culture in the Old World. These essays are very suggestive, and it is to be expected that the results of experiments and studies made by the present commission will lead to discoveries and records of equal value, should the commission be maintained by the government for a sufficient number of years.

HYATT'S NORTH AMERICAN SPONGES.[1] — The second part of this elaborate revision of our North American sponges contains a good many novel and interesting facts regarding the influence of temperature and the nature of the sea-bottom upon the growth, variation, and distribution of our useful sponges, as well as the mode of fishing for and preparing them for the market. Professor Hyatt regards the sponges as forming "a distinct sub-kingdom or branch of animals, equivalent structurally to the Vertebrata or any of the larger divisions which are characterized by the most important structural differences." The excellence of the plates shows how well photography may be applied to the delineation of these animals.

RECENT BOOKS AND PAMPHLETS. — Reconciliation of Science and Religion. By Alexander Winchell, LL. D. New York? Harper and Brothers. 1877. 12mo, pp. 403.

Proceedings of the Davenport Academy of Natural Sciences. Vol. ii., Part I. January, 1876–June, 1877. Davenport, Iowa, July. 1877. 8vo, pp. 148. 3 plates.

Account of the Discovery of Inscribed Tablets. By Rev. J. Gass. With a Description by Dr. R. J. Farquharson. (Proceedings of the Davenport Academy of Natural Sciences, vol. ii.) Davenport, Iowa, July, 1877. 8vo, pp. 23. 3 plates.

List of the Vertebrated Animals now or lately living in the Gardens of the Zoological Society of London. Sixth Edition. London. 1877. 8vo, pp. 519, with cuts.

Zur Morphologie des Tracheensystems. Von Dr. J. A. Palmén. Helsingfors. 1877. 8vo, pp. 149. 2 plates.

Annual Report of the Entomological Society of the Province of Ontario for the year 1876. Toronto. 1877. 8vo, pp. 58.

On the Dispersal of Non-Migratory Insects by Atmospheric Agencies. By Albert Müller (Basileensis). (Reprinted from Trans. Ent. Soc. Lond. 1871.) Basle. 1877. 8vo, pp. 16.

Report of the Director of the Central Park Menagerie, Department of Public Parks, City of New York, for year 1876. New York. 1877. 8vo, pp. 34.

Bathybius und die Moneren. Von Ernst Haeckel. 8vo, pp. 12. 1877.

Brehm's Thierleben. Bd. 2. Heft i.–iv. Leipzig. 1877. New York: B. Westermann & Co. 40 cents a Heft.

De for Ager, Eng, og Have skadeligste Insekter og Smaakryb. Af W. M. Schoyen. Kristiania, 1875. 12mo, pp. 212. 8 plates.

[1] *Revision of the North American Poriferæ.* With Remarks upon Foreign Species. Part II. (Memoirs of the Boston Society of Natural History, vol. ii., Part IV., No. 5. Boston, May 28, 1877. 4to, pp. 73. 3 carbon photographs.

De i Husene skadeligste Insekter og Midder, der angribe og bedœrve vore Madvarer, Klœder, Bohave og svrige Eiendele under Tag. Af W. M. Schoyen. Kristiania, 1876. 12mo, pp. 102. 3 plates.

Enumeratio Insectorum Norvegicorum. Fasciculum III. Catalogum Lepidopterorum Continentem. Auctore H. Siebke defuncto, edidit J. Sparre Schneider. Christiania, 1876. 8vo, pp. 188.

Enumeratio Insectorum Norvegicorum. Fasciculum IV. Catalogum Dipterorum Continentem. Auctore H. Siebke defuncto, edidit J. Sparre Schneider. Christiania, 1877. 8vo, pp. 255.

Some Remarkable Gravel Ridges in the Merrimac Valley. (Abstract.) By George F. Wright. (From the Proceedings of the Boston Society of Natural History, vol. xix.)

I. On the Brains of some Fish-Like Vertebrates. II. On the Serrated Appendages of the Throat of Amia. III. On the Tail of Amia. By Burt G. Wilder. 1876. 8vo, pp. 10, with a plate. (From the Proc. Am. Ass. Adv. Sci. Buffalo Meeting, August, 1876.)

GENERAL NOTES.

BOTANY.[1]

VIOLETS. — Most of our readers are aware that many species of violets have, in summer, flowers which are totally unlike the showy, attractive blossoms of early spring; for instance, the lance-leaved violet and the arrow-leaved violet bear late, inconspicuous flowers, in which the petals are reduced to the merest rudiments, and only two or three stamens with pollen are present. Flowers of this sort have long been known, but they need to be more carefully examined with reference to their specific peculiarities. It is proposed to give in this note a preliminary sketch of the literature of the subject, in the hope that some of our botanists may collect and study the forms here referred to. Dillenius, in 1732, (Hort. Eltham, 408) observed that *Viola mirabilis* has flowers of two kinds: the spring flowers, with well-developed corolla and stamens seldom produce fruit, but the later flowers, in which he found stamens and no petals, always do. Linnæus (Semina Muscorum Detecta, 1732) refers to *Viola mirabilis* as one of the plants which had been thought to bear fruit without any antecedent blossoms; but he states that in the case of this plant, as in others referred to, blossoms with good stamens and pistils are present. It is said by Dr. Oliver that in a later work Linnæus remarks of *Viola mirabilis* that "the early flowers provided with a corolla are often barren, while others, appearing subsequently, and destitute of a corolla, are fertile."

Conrad Sprengel (1793) refers to *Viola mirabilis* as bearing two kinds of flowers, but states that he had not had an opportunity of examining the plant.

In 1823, De Gingins, in his Mémoire sur la Famille des Violacées, page 11, writes that "most of the species of the section of violets properly so-called have the singular property of sometimes producing incomplete

[1] Conducted by PROF. G. L. GOODALE.

flowers more or less destitute of a corolla; their fruits are nevertheless as perfect as, or even more perfect than, those which follow complete flowers. This phenomenon is observed frequently in autumn at the second blooming of violets; and the exotic species transplanted to our gardens have, under unfavorable conditions, apetalous flowers with deformed essential organs, which nevertheless bear perfect fruit."

From Dr. Oliver's review, previously referred to, we take the following notice of a work to which we do not have present access. M. Monnier, of Nancy (Guillemin's Archives de Botanique, 1833), says that none of the early spring flowers of *Viola hirta* bear fruit. "After the first flowering the leaves take on a further development: they become hairy, and bear in their axils flowers destitute of a corolla and with the five stamens almost always distinct and shorter than the ovary. The peduncles bearing these flowers curve downwards and bury the ovaries under the surface of the soil, where the seeds are ripened."

In a review given at second hand in *Botanische Zeitung* for November, 1854, are some quotations from a memoir by Timbal-Lagrave (On the Genus Viola, 1853): "It is the custom in botany to examine a plant when it is grown, that is, when it has completed its development or has reached the climax of its vegetation and is in flower. This usage, well enough for most cases, is faulty when it is applied to the section *Nominium* of *Viola.* It has here led botanists into errors and doubts, which have rendered the study of this section a matter of great difficulty. The period of early blossoms in *Viola* is the *youth* of the plant; its old age is another epoch in its development which was unknown to the older botanists, and herein lies the ground of the difficulties. . . . . In the stemless violets the following facts can be observed: in early spring a few leaves appear, and these develop until April; then come the blossoms with richly colored petals, and often with some fragrance, but these flowers, although provided with essential organs, are infertile. At first I believed that this anomaly is dependent on some modification of the stigma, or caused by some atmospheric influence, but I am now convinced that it arises from the lack of pollen in the anthers; fertilization cannot take place; the flower soon fades, dries up, or decays without any result.

"In this period, which I call youth, a new growth takes place: from the cluster of persistent radical leaves accompanying the first flowers new leaves arise, which soon become large and acquire firmness, having even larger and stiffer hairs. Towards the end of May and June new flowers come up, but they are very different from the first. In some species the blossoms have no petals, in others only one or two, but these are always inclosed in the calyx and are frequently the merest rudiments. The whole floral apparatus is modified, and yet fertilization takes place. . . . . A comparative study of the different organs of the first and second flowers of these plants, the growth or the abortion of this or that part, the position, the duration, and the functions, afford many essential characters

which, added to those already known, will aid in the study of this genus."

In *Botanische Zeitung* for October, 1857, Daniel Müller, of Upsal, gives an instructive account and a few figures of the incomplete flowers of certain violets. He states that the anthers contained only a few grains, which did not seem to him like perfect pollen, but rather like minute ovules. In spite of a whimsical theory with which he closes his paper, the account must be valued for the accurate descriptions of the incomplete flowers of several species.

A very interesting paper on this subject was read in July, 1860, before the Botanical Society of France, by M. Eugène Michelet. The statements made by him agree essentially with those just given.

In 1863, Von Mohl (in *Botanische Zeitung*) gives an abstract of the literature relating to cleistogamic flowers, and presents some instructive results of his own observations, of which the following is an abstract: "The process of fertilization in *Viola elatior* F. was more easily investigated than in the other species examined. In this species, as in all apetalous violets, the style is short and hooked, and in immediate contact with the anthers with which it alternates. Besides these two stamens which in this plant I always found developed, I discovered in some flowers one or two more. Although the anther cells are only one seventh to one sixth of an inch long, they have a number of pollen grains. The greater part of these push forth pollen tubes even while they are still in the anther, and these tubes pass out of the upper end of the anther cells, in thick strings, directly to the contiguous stigma. If the stamens in a fresh flower are drawn away from the stigma, the tubes will not break, but the pollen grains will be released from the opened anther cell, so that the latter will be left empty. On tearing away the anthers, some pollen grains which have not pushed out any tubes will fall out from them. It appears to me questionable whether without such a mechanical process pollination from these would take place; at least I have not observed any such case. With the drying of the anthers after fertilization, the tubes in their course from the anthers to the stigma dry up also, and then break off when the anthers separate, without withdrawing the pollen grains which are there held fast. Similar appearances are presented by the anthers in *Viola canina*, which touch the stigma. Besides this, it is seen that from those anthers, which in this species are always turned away from the stigma, pollen tubes start out and pass down in a serpentine course over the upper part of the ovary and the back and sides of the style. This observation is easily made by means of a Lieberkühn illuminating mirror. In this species, also, I frequently found pollen grains which had fallen out of the anthers, but I am not sure whether this discharge takes place naturally; for if we examine anthers which have become dry after fertilization, and on which, therefore, while fresh no force could have been exerted, they will be found

thickly filled with pollen grains. These are colorless, finely dotted, and thin-walled, and they wrinkle up when drying.

"The pollen grains of *Viola mirabilis* fall out from the anthers more easily and in greater abundance, and this may be regarded as of regular occurrence. The number of pollen tubes which run from the anthers to the stigmas is far smaller than in the other species spoken of, and the anthers are not so finely fastened on the stigma. Here, too, a part of the pollen will be pulled out by its tubes when the anthers are detached." Von Mohl closes this part of the memoir by stating that, owing to the changes which the pollen of the late flowers undergo in drying, or on access of water, it has been impracticable to compare the pollen of the early large-blossoms with that of the late, inconspicuous ones. He further states that in these late flowers fertilization by the pollen of any other flower is of course an impossibility.

It may here be said that, as Timbal-Lagrave suggests, the characters of the late flowers of violets can be of aid in distinguishing species. Koch in his Synopsis has a section headed Flores Seriores Apetali, Later Blossoms without Petals. We do not know of any attempts other than those mentioned above to separate species by means of these peculiarities.

In Kuhn's Memoir, in *Botanische Zeitung* for 1867, a list of forty-four cleistogamic flowers is given, in which *Viola* is mentioned.

Lastly, in Mr. Darwin's new work, Forms of Flowers, 1877, the whole subject has received most careful attention.

Silphium Laciniatum. — Sections of fresh leaves of *Silphium laciniatum*, the compass plant, show that the parenchyma is composed of "palisade tissue," that is, of the tissue which occurs only immediately beneath the upper surface in most leaves.

Not only are both upper and under surfaces provided with the tissue usually regarded as peculiar to the upper portion of the leaf, but the whole of the leaf pulp from one surface to the other is also composed of it. There are often as many as six closely packed layers of palisade cells. — C. E. Bessey.

Sarracenia Variolaris. — The experiments referred to in the June number of the Naturalist have been repeated by me several times of late, and with uniform results. At the last meeting of the Botanical Section of the Boston Society of Natural History the experiments were again tried in the presence of the members. The results agreed perfectly with those detailed by Dr. Mellichamp. — B. M. Watson, Jr.

Botanical Papers in Recent Periodicals. — *Flora*, No. 16. E. Pfitzer, Observations in Regard to the Structure and Development of Epiphytic Orchids (dealing with the peculiar long cells in the tissue of *Ærides*, and with the occurrence of silicious discs in the pseudo-bulbs of epiphytic orchids, continued in No. 17). Gandoger, New Roses from Southeastern France. No. 17. Dr. Carl Kraus, Causes of the Unver-

tical Direction of Growth of Shoots. Schulzer, Mycological Notes. No. 18. Dr. Oskar Drude, *Agrostis tarda*, a New Species in the Flora of the Alps. F. Arnold, Lichenological Notes. J. B. Kreuzpointner, Notice in regard to the Flora of Munich.

Botanische Zeitung, No. 26. Prof. Schenk, A Contribution to our Knowledge of the Structure of the Fruits of *Compositæ* and *Labiatæ*. Reports of Societies. No. 27. Christoph Gobi, On a Mode of Growth of the Thallus of *Phæosporeæ*. Dr. Wilh. Jul. Behrens, The Flowers of Gramineæ. Celakovsky, The Theory of the Ovule. Reports of Societies. Nos. 28 and 29. J. Reinke, Remarks in Regard to the Growth at the *Punctum Vegetationis* of *Dictyodaceæ* and *Fucaceæ*. Reports of Societies.

ZOÖLOGY.[1]

RARE SNAKES FROM FLORIDA. — Mrs. A. D. Lungren, of Volusia, has made collections in natural history which have added a number of facts of interest to the herpetology of Florida. She has obtained the *Contia pygæa*, a calamarian form, of which but two specimens are known, both from Volusia. The second specimen of *Dromicus flavilatus* comes from her collections. It will be remembered that the first specimen of this rare species was procured by Dr. H. C. Yarrow, on the coast of North Carolina, at Fort Macon. She has also found the *Helicops Allenii* in the same neighborhood, and a new species of *Chorophilus* (*C. verrucosus* Cope). Persons desiring collections from that region, in any department of natural history, cannot do better than communicate with her. — E. D. C.

RED-BELLIED NUT-HATCH (SITTA CANADENSIS) NESTING ON THE GROUND (?). — On the 27th of May the son of a neighbor brought me four eggs from a nest he discovered in the woods, stating that it was built in a hole in the ground, and that he found it by the old bird's leaving it and attempting to lead him away by the well-known artifices of many ground-building birds. The nest contained six eggs, white, with a faint blush, well covered, especially at the larger end, with coarse reddish-brown spots, mingled with a few faint lilac ones. While he was removing the eggs the bird was very courageous, and seemed much inclined to attack him, but when frightened away alighted on the side of a tree, up which she ran "like a woodpecker." He described the bird as follows: In size, quite small; color of back, blue; of breast and under parts, reddish-brown, a very little white on it, and quite a long bill. As this description was volunteered without any questioning on my part, I think it must be quite correct; and, taken with the climbing habits of the bird, I can think of no bird which it can indicate but the red-bellied nut-hatch, though I have never known that bird to be described as nesting elsewhere than in a tree or stump. The eggs meas-

[1] The departments of Ornithology and Mammalogy are conducted by Dr. ELLIOTT COUES, U. S. A.

ured .65X.55, and were quite fresh. The next morning I visited the nest, hoping to see the bird and obtain the remaining eggs, but they had been removed, probably by the old bird, as the nest was unknown to other persons. The nest was built about a foot from the base of a pine amongst a clump of those trees, and was about two inches in diameter and four in depth, going down through the pine needles to the ground; and on a few of the needles the eggs were laid. If I am right in my conclusions as to the species, I think that this case must be quite unique both in locality and method of nesting. — FRANK H. NUTTER, West Roxbury, Mass.

ON A TRANSITORY FŒTAL STRUCTURE IN THE EMBRYOS OF SERPENTS AND LIZARDS.[1] — In the prosecution of his studies in biology the student cannot fail frequently to meet with structures and organs destined to have but a transient existence. A closer insight into the nature of these cases reveals the fact that they are naturally divisible into two groups. In one group, these structures, although very transient in their duration, subserve, while they exist, important functions, and are often quite indispensable to the development of the embryo. In the other group the most rigorous investigation fails to detect any purpose connected with the life of the subject for which they were called into existence. They serve only as illustrations of a general plan of development. Such are the rudimentary teeth developed in the jaw of the whalebone whale (*Balæna mysticetus*) prior to the appearance of baleen plates or permanent teeth, and corresponding rudimentary incisive teeth in the upper jaw of the Ruminantia, which are never followed by teeth having any functional character.

To the former group belong all those obvious and essential structures in the development-history of the mammalia, including also a few whose function seems so simple and transient, yet often important, as to be frequently overlooked. It is to one of the latter class to which we wish to draw the attention of the society.

It is a fact well known even to common observation that at the end of the beak of the fœtal chick there exists a sharp process or horn which is evidently employed instinctively to break the brittle shell of the egg when the chick has arrived at fœtal maturity. A very similar structure is found on the beak of some of the embryo turtles; at least in the genus *Emysaurus* in that group of reptiles. In both birds and reptiles it disappears soon after exclusion from the egg.

Somewhat recently, Dr. Weinland, of Germany, claims to have discovered in all the snakes of that country, and in many lizards, that a small, sharp tooth is developed in the premaxillary bone of the upper jaw designed to cut and tear the tough egg membrane that surrounds the fœtus, and thus furnish important aid in its liberation. This observation of Dr. Weinland is quoted by Owen in the last edition of his great

[1] Presented to the Ann Arbor Scientific Society, July, 1876.

work on Comparative Anatomy, and also by Agassiz in his Contributions to the Natural History of the United States, and by both writers with acceptance, but without personal verification. My observations, which have been made upon embryos of several genera and species of serpents and lizards of this country, have not enabled me to confirm the observations of Dr. Weinland; on the contrary, I feel quite sure that no such structures exist in the fœtuses of the genera *Eutænia* and *Storeria* among our snakes, nor in the fœtus of the genus *Scincus* among lizards. But without expressing a doubt about the correctness of the observations of Dr. Weinland, I am compelled upon the basis of my own researches to call in question the universality of the rule; and as the indorsement of Professors Owen and Agassiz is without personal verification, I cannot regard them as having any positive value in the decision of such a question. — A. SAGER.

ANTHROPOLOGY.

ANTHROPOLOGICAL NEWS. — *Ergänzungsheft* 50 of Petermann's *Mittheilungen* contains E. de Pruyssenaere's account of his journeys and discoveries in the region of the White and the Blue Nile. The seventh chapter (pp. 18–27), relates to the population of the Upper White Nile, and especially to the Dengas.

Murray issues a volume entitled, The Cradle of the Blue Nile; A Visit to the Court of King John of Ethiopia, by E. A. de Cosson.

In *Nature*, April 26th, is a lengthy review of a paper on the races and tribes of the Chad Basin, in *Zeitschrift der Gesellschaft für Erdkunde*, by Dr. G. Nachtigall.

We have received from the author, W. L. Distant, two pamphlets, reprints from the *Journal of the Anthropological Institute*, entitled respectively, On the Term Religion as used in Anthropology; and, Our Knowledge of the Nicobarians. The same gentleman exhibited to the Institute, April 24th, photographs of the people of the Andaman and Malacca islands.

The Journal of the Victoria Institute, vol. x., just issued, contains some valuable articles reviewing the grounds of modern speculations, especially in England.

Nos. 3 and 4 of *Matériaux* appear together. The principal communication of importance to students, outside of France, is that of M. Ernest Chantre, describing the collections of bronze implements exhibited at the last meeting of the Congress of Prehistoric Archæology, held during the past summer at Buda Pesth.

The Russian Geographical Society will publish a description of the upper part of the Oxus, of the Hindoo Koosh, and of the Western Himalayas. The work will be accompanied by ethnographical maps and vocabularies.

In *The Academy* for April 21st and 28th, Mr. Percy Gardiner reviews

at length the discoveries of Dr. Schliemann, at Mycenæ. He concludes that the supposed analogy of the treasures to Byzantine work is delusive, and that they are of a very early date.

In *Popular Science Monthly* for June, Herbert Spencer writes on The Evolution of the Family, and Prof. Wm. B. Carpenter on Mesmerism-Odylism, Table Turning, and Spiritualism.

In the *Atlantic Monthly* for May, Mr. Edward H. Knight begins a series of illustrated articles on Crude and Curious Inventions at the Centennial Exhibition, commencing with musical instruments.

The *Nineteenth Century* for June contains an article on Infanticide, by C. A. Tyffe.

Dr. Dalrymple, of Baltimore, sends us an interesting pamphlet entitled, Excerpta ex Diversis Litteris Missionariorum, issued during the first part of the present year.

In the Transactions of the Wisconsin Academy of Science, etc., vol. iii. 1875–1876, the following archæological papers appear: The Ancient Civilization of America, by W. L. J. Nicodemus; Copper Tools found in the State of Wisconsin, by J. D. Butler; Report of the Committee on Exploration of Indian Mounds in the Vicinity of Madison.

Dr. Gustav Bruhl has sent to the Smithsonian Institution four pamphlets, printed in German, on Die Culturvölker Alt Amerikas, treating of the Mississippi Valley, Mexico, Chiapas and Yucatan, and Central America.

An article in the *Church Gazette*, x., No. 4, New York, treats of the Proto-Historic Settlement of America.

Prof. J. Hammond Trumbull sends to the *Magazine of American History*, June, a note on the Indian names of places on Long Island, derived from esculent and medicinal roots.

Before the Anthropological Institute of London, April 24th, three papers were read on American subjects: On the Migrations of the Eskimo, by Dr. John Rae; On Earthworks in Ohio, by Robert B. Holt; Note on Skulls from Ohio, by Prof. Geo. Busk.

The Annual Report of the Commissioner of Indian Affairs and that of the Board of Commissioners must not be overlooked in the summary of contributions to American ethnology. The map of the location of tribes in the former is especially valuable. — Otis T. Mason.

GEOLOGY AND PALÆONTOLOGY.

Pan-Ice Work and Glacial Marks in Labrador. — In an article in the *Canadian Naturalist* (viii. No. 4), entitled Notes on some Geological Features of the Northeastern Coast of Labrador, Prof. H. Y. Hind describes the action of pan-ice in abrading and polishing the rocks both above and below the sea level. He gives an account of the mode of formation of the remarkable gneiss steps or terraces in Tooktoosner Bay, south of Hopedale, and in Lake Melville, Hamilton Inlet. His

observations fully supplement and corroborate the writer's[1] statements made ten years ago in a paper which Mr. Hind has evidently overlooked. Mr. Hind personally traced this action of shore ice to an altitude of six hundred feet above the ocean, — we had at a rough estimate put the height of these rock terraces at five hundred feet above the sea, — and concluded that the action of the shore ice reached the height of one thousand feet (p. 222), a conclusion independently formed by Mr. Hind (*Can. Nat.*, p. 231), as he remarks that "erratics and local rounded fragments of rock are not numerous until a height exceeding one thousand feet is attained, and even then, except perhaps in hollows, which I had no opportunity of examining, bowlders and perched rocks are very much less numerous than at greater elevations in the far interior, where I saw them in countless multitudes in 1861." We differ, however, from Mr. Hind in considering that this work of abrasion is performed rather in the autumn, winter, and especially in the spring when the ice is breaking up, and is due almost exclusively to ice formed on the shore rather than in part by floe ice which comes down from the north after June.

In Tooktoosner Bay, Mr. Hind saw, "in a secluded and protected hollow, well-marked and deeply cut grooves. They occupied a shallow and cup-shaped basin, but all surrounding surfaces were smoothly polished, pan-ice having removed every trace of groove or striæ." Professor Hind concludes that no ice-foot is formed on the Labrador coast or in Greenland, but we should be disposed to question the validity of this conclusion, as we are inclined to ascribe the wearing and polishing of the rocks rather to ice formed on the coast than to foreign ice floating past the shore in summer. Professor Hind's conclusion we present in the author's own language: —

"It has been shown by Dr. Petermann and others that the difference between the coastal climate of Greenland and the Labrador is very great. The southwestern coast of Greenland is much milder than that of the Labrador in the same parallels.[2] A surface sheet of warm water, floating from south to north, is determined on to the coast of Western Greenland by the rotation of the earth. A cold arctic current laden with ice from Davis and Hudson straits flows from north to south and is determined on to the Labrador coast by the rotation of the earth. Hence the sea on the Labrador coast is cooled sometimes in November and early in December to 29°, and even 28°, and the lolly of the sealers, or ice spiculæ, or anchor ice, forms rapidly during the first cold snap in November, along the entire coast line; and before Christmas, all the coastal waters within the zone of islands are frozen in one solid sheet, so that no ice-foot is formed on the Labrador like the ice-foot on the Greenland shores. In brief, it may be said that the stupendous work of

[1] Glacial Phenomena of Labrador and Maine. Memoir of the Boston Society of Natural History, vol. i., 1867, pp. 225, 228. By A. S. Packard, Jr.

[2] Vide a paper entitled Further Enquiries on Oceanic Circulation, by Dr. W. B. Carpenter, F. R. S., Proceedings of the Royal Geological Society, August, 1874.

ice on the Labrador, apart from glacial sculpturing, appears to be almost altogether due to the periodical action of pan-ice deriving its power and constant opportunities from the arctic current, which presses continually on the Labrador coast."

New Fossil Fishes from Wyoming. — At a recent meeting of the American Philosophical Society, Professor Cope announced the discovery of a new locality of the Green River shales, containing fishes, insects, and plants in a good state of preservation. Owing to the rather soft nature of the matrix the characters of the fishes could be worked out with much nicety. A collection which he had recently received includes sixteen species of fishes, mostly new. Their names are as follows: —

? *Chromididæ: Priscacara serrata* Cope; *P. cypha* Cope; *P. liops* Cope.

Percidæ: Mioplosus abbreviatus Cope; *M. labracoides* Cope; *M. Beanii* Cope; *M. longus* Cope.

Asineopidæ: Asineops pauciradiatus Cope.

? *Aphredodiridæ: Erismatopterus Endlichii* Cope; *Amphiplaga brachyptera* Cope.

Clupeidæ: Diplomystus dentatus Cope; *D. analis* Cope; *D. pectorosus* Cope; *D. humilis* Leidy; *D. altus* Leidy.

Osteoglossidæ: Dapedoglossus testis Cope: *D. encaustus* Cope.

Of the above genera all but two are new to science, and all of the species but three are likewise new. From the present collection something like a general view of the ichthyological fauna can be obtained, since the predominant types are probably represented in it. *Priscacara* is a Pharyngognath allied to the *Chromididæ* and *Pomacentridæ*, most nearly to the former; and *Dapedoglossus* is not far removed from *Arapæma* and *Osteoglossum*. The facies of the fauna is of a mixed character, both fresh-water and marine types being present. The largest species is the *Osteoglossum encaustum;* the second in size is the *Diplomystus dentatus*, which exceeds the moss-bunker (*Brevurtia menhaden*).

The species and genera are in process of publication in the Bulletin of the U. S. Geological Survey of the Territories.

GEOGRAPHY AND EXPLORATION.

Rise of Great Salt Lake. — While I was spending a few days in June last at Salt Lake, my attention was called to the evident rise in the Great Salt Lake, which had taken place since my last visit to the lake, in August, 1875. The point where I noticed the fact of a rise was at Farmington, Utah, where from overflowed salt vats that were above water in 1875, and from the wearing away of the shore, I roughly judged that the lake had risen at least twelve inches. Mr. W. V. Haight, a farmer, who owns the land at the point visited, confirmed my impressions. At Lake Point, twenty miles east of Salt Lake City, the captain of the steamer General Garfield informed me that

from marks made by himself, on the piles of the wharf, the lake is fifteen inches higher than in July, 1875. It is to be hoped that the U. S. geologists will measure the oscillations of the lake.

GEOGRAPHICAL NEWS. — The *Geographical Magazine* for June contains a map of the seat of war in Asia, which is intended to assist its readers in following the military operations now being carried on in Asia. The editor observes that it possesses but few claims to accuracy, for of the countries delineated only a small portion has been made known to us through the surveys of Russian officers and of other Europeans, some of them in the service of Turkey.

Corea having entered into a treaty with Japan, there are prospects that this last of exclusive nations in the far East will have intercourse with other countries. A general account of Corea is given in the *Geographical Magazine*. A new map of Japan has been compiled by R. H. Brunton, formerly engineer-in-chief of the Japanese Light-House Department. It is said to be the only map of Japan which can be consulted with confidence. It is published by Trübner & Co., London. The Darien Exploring Expedition, under command of M. Lucien N. B. Wyse, returned to Panama early in April. M. Wyse has expressed his conviction, based on the results of these surveys, that the interoceanic canal will soon be made through Columbia. The proposed canal will have a length of 143 miles, including 46 miles of the Atrato and 43 of the Tuyra, which can be rendered navigable at small expense. At the confluence of Tuyra and Pucro the elevation above the sea is 92 feet, and it appears from a reconnaissance that the height of the water parting at the head of the Tihule does not exceed 230 feet. The late Dr. Maack, who was attached to the American Expedition as geologist, ascertained that the two oceans formerly communicated near this spot. The fossils discovered belonged to species still existing in the two oceans, The engineers would, therefore, only have to break through this barrier, which has been formed by an upheaval of the tertiary strata.

At the meeting of the Berlin Geographical Society, held May 12th, Baron Richthofen read a paper on the roads followed by the silk trade, according to Ptolemy and the Chinese authorities. It was announced at this meeting that Dr. Nachtigal proposed to start for Western Africa next year. In the mean time, it is proposed to dispatch a pioneer explorer to follow in the footsteps of Pogge and Mohr.

MICROSCOPY.[1]

ANOTHER MECHANICAL FINGER. — Mr. Hanks, of San Francisco, Cal., at a recent meeting of the San Francisco Microscopical Society described a device used by him for picking up objects under the microscope, which answers nearly all the purposes of the most elaborate mechanical finger, and at the same time requires no extra apparatus. For the

[1] Conducted by DR. R. H. WARD, Troy, N. Y.

purpose of lifting the object slide, when required, off the stage, the glass parabola is mounted in the substage in such a position that it can be raised by the substage rack until its upper surface is just above the level of the stage. The stand is arranged vertically, and a hair is placed in the stage forceps. For small objects a human hair is sufficient, but for larger ones a bristle is required, and it may even need to be slightly moistened when used, the object adhering while it is wet and falling off readily as it dries. If the hair is not easily held by the forceps, one end of it may be cemented between two small pieces of thick paper which are easily held. The slide containing the rough material is laid on the stage and the desired object selected and accurately centred; it is now, by the rack or sliding movement of the substage, lifted off the stage so as to be no longer affected by the stage movements. The end of the hair is next arranged just above the level of the object and centred exactly over it by means of the stage movements. Having got the end of the hair in the centre of the field, and having placed the object, dimly seen out of focus, below it, a slight elevation of the substage, which is still supporting the slide, will bring the object in contact with the hair and leave it there when the slide is lowered again. A fresh slide can then be substituted and brought up to the object on the hair, the exact position where it shall touch being secured by the stage movements, if the substage has no centring adjustments. Where the substage has rotating and centring movements of its own the performance is most complete and accurate.

It will be noticed that the principle of this method is the same as that of Dr. G. C. Morris,[1] the novelty consisting in the excellent suggestion of carrying the hair on the stage forceps instead of on a special arm clamped to the stage.

New Physician's Microscope. — For convenience of those who prefer a stand of the compact, Continental model, the Bausch & Lomb Optical Company, of Rochester, have designed a new form of instrument which they call the physician's microscope. In this stand Mr. Gundlach has reproduced the Continental model so well worked out by him while in Europe, with several of the novel features of the Rochester styles, such as his new fine adjustment, the hard-rubber stage and mountings, and the new students' series of objectives.

Tin Cells. — Prof. George F. Markoe, of 61 Warren Street, Boston, Mass., has had a set of dies prepared with which he is now able to produce tin cells of various sizes and excellent quality. Microscopists can obtain these serviceable cells from him, by mail or otherwise, at a reasonable cost.

Exchanges. — Diatoms from coörongite, from South Australia, for good mounted objects. Address Galloway C. Morris, East Tulpehocken Street, Germantown, Philadelphia.

Shell sand from the Bermuda Islands, for any really valuable mate-

[1] See Arranging Diatoms, in the Naturalist for August, 1876, p. 502.

rial; or selected shells from the same, for mountings of special interest. Address C. C. Merriman, Rochester, N. Y.

Insects' eggs; also American podura. Whole insects or scales. Address George W. Frees, Friendship, N. Y.

Algæ from California and Japan, on which are fine circular diatoms. Address W. C. J. Hall, Jamestown, N. Y.

Scales of hunting spider, *Salticus senicus*. Address William Readio, Garnerville, Rockland County, N. Y.

Oölitic sand from Salt Lake. Address F. H. Atwood, 160 Lasalle Street, Chicago, Ill.

Lupulin crystals in extract of hops. Address Richard Allen, 146 North Fourth Street, Troy, N. Y.

Diatoms from Keene, N. H. Address Edwin S. Gregory, Youngstown, Ohio.

Diatoms from Lake Superior; dredgings eight feet deep near the head of Portage Lake. Address Dr. T. U. Flanner, Springfield, Mo.

A variety of mounted objects for exchange. Address offers to Frederick A. Eddy, 89 State Street, Bangor, Me.

SCIENTIFIC NEWS.

— Dr. Joseph D. Hooker, keeper of the Kew Botanical Gardens, England, and Professor Asa Gray, of Cambridge, are both temporarily attached to the U. S. Geological and Geographical Survey of the Territories, Dr. F. V. Hayden, U. S. Geologist, in charge. In company with Dr. Hayden they have visited various portions of Colorado, making the ascent of Gray's Peak, and exploring the interesting flora of the mountains and parks, as well as that of the foot-hills and adjacent plains. Previous to August 1st, these eminent botanists had collected nearly four hundred species of rare plants, being thus enabled to study critically in their native habitats the species they had during past years described from dried specimens brought in by expeditions. Both of these gentlemen will prepare reports on the botany of the West for the Eleventh Annual Report of Hayden's Survey. A preliminary report by Dr. Hooker is already well advanced. After a sojourn of several weeks in Colorado and Utah, they left Salt Lake City, August 11th, for the Pacific Coast.

— The Summer School of Biology at the Peabody Academy of Science, Salem, Mass., opened July 7th with twenty-one laboratory students, while a few others attend the daily lectures. This is a larger number than were present last year. Lectures have been given by Mr. J. H. Emerton, Rev. E. C. Bolles, Mr. John Robinson, Professor J. Ramsay Wright, of Toronto, Rev. T. C. Hervey, Mr. C. S. Minot, and Dr. Packard. Material for dissection from Woods Holl, Mass., has been contributed by Professor Baird, U. S. Commissioner of Fish and Fisheries.

— It should be stated that the review of Ganin's Metamorphoses of Insects in the July NATURALIST was contributed by Baron C. R. Osten-Sacken. As the original was in the Russian language, no one else in this country was probably competent to perform the task.

— Captain Howgate, U. S. N., has obtained from the friends of his Polar colonization plan the means of chartering the schooner Florence, which sailed July 25th from New London for the arctic regions, for the purpose of making a preliminary exploration of Northumberland Inlet, with the view of establishing a post there next year.

— The Académie Royal Danoise des Sciences et des Lettres proposes among its prize questions for the year 1877, the following: The gold medal of the Academy is offered in competition for memoirs, based on original research, respecting the external and internal structure met with in (*a*) individuals which turn to the left, as compared with that of those which turn to the right, belonging to the same species, as, for example, among Vertebrates, the flounder and other flat fishes, and, among Gasteropoda, the genus *Verruca;* (*b*) the same in species turning to the left, as compared with others turning to the right, which belong to the same genus, as, for example, the genera *Fusus*, *Vertigo*, *Turritella*, *Chama*, etc.; (*c*) the same in genera turning to the left, as compared with genera turning to the right, belonging to the same family, as, for example, the turbots and the true *Pleuronectidæ*, and the genera *Clausilia* and *Pupa*, *Lanistes* and *Ampullaria*, *Physa* and *Planorbis*, etc. The Thott prize of four hundred crowns is offered for memoirs on the anatomy, life-history, and development of the species of *Ligula*, with special reference to their relationship to the Platyhelminths. Memoirs offered in competition for these prizes should be accompanied by figures and preparations which may serve as a guaranty for the correctness of the anatomical results obtained.

— There will be room for one or two special students in zoölogy at the Peabody Academy in October. Address A. S. Packard, Jr., Director Peabody Academy of Science, Salem.

— The following is taken from the *Philadelphia Ledger Supplement*, May 5, 1877: —

MR. EDITOR, — If you will, let me in a plain, simple way revive the memory of your oldest readers, feeling that some of them may visit the grave of Professor S. C. Rafinesque, Ronaldson's Ground, Ninth and Bainbridge streets. Rafinesque was born in France, of parents in high position. He was an orphan, yet his means gave him a classical education. He visited the four quarters of the globe. In his first trip to America he was shipwrecked on Nova Scotia, losing a part of his fortune. Having spent one or two years in the United States he returned to Europe. A few years later he returned to Philadelphia. Rafinesque was a devoted naturalist. To conchology he gave much of his time and labor, collecting a great variety of shells, publishing a volume illus-

trated with engravings. He also published a work on grape-vines, giving the mode of making wine. After suffering many vicissitudes and losses in money, and having accumulated scientific treasures, he gave his entire attention to the science of botany. He traversed this continent from Nova Scotia to Mexico, from the Atlantic coast to the Rocky Mountains. In every State and Territory he pursued his way on foot and alone in his devotion, over valleys and mountains, often depending upon the kindness of Indian tribes. After several years of constant labor he returned to Philadelphia. He was a bachelor, consequently peculiar in his habits. He selected a garret for his labors, and abode in Race Street between Third and Fourth. In this secluded place, surrounded with his herbarium, his sketches, and pencil drawings, with hard cot and pillow, often with a bare loaf of bread, he performed his last work, The Family Flora and Medical Botany of the United States. This work on the science of botany was more extended and correct than anything before it. It was printed and published in 1828, by the late Samuel C. Atkinson, who established the *Saturday Evening Post*, Carter's Alley.

Without kindred, and with but one reliable friend, the late Dr. Mease, of Philadelphia, Rafinesque died in the year 1840. After his remains had been cared for by Dr. Mease, the body was stealthily removed (probably by creditors), and locked in an adjoining room of the house where he died. In presence of Dr. Mease and Mr. Bringhurst, undertaker, Eleventh Street, near Arch, the door was forced open, and the body was let down by ropes into the back yard and conveyed to its last place of rest.

Some sixteen years ago I called on Mr. Bringhurst, who assured me of these facts relating to the burial. I visited the burial ground. The sexton referred to his records and took me to the grave of Rafinesque. A small painted head-board had the initials S. C. R.

Rafinesque published several volumes and essays in the French and English languages. Two years since I forwarded his last work to the National Library of France, and received acknowledgment through the French consul, Philadelphia. — H. H.

— The Central Pacific Railroad Company are doing a good work in tree planting, having already purchased forty thousand Eucalyptus trees to plant along the line of their road. This enterprising company intend planting certain species of the Eucalypti on each side of their right of way through some five hundred miles of the valleys of California; it is estimated that eight hundred thousand trees will be required for this purpose. — R. E. C. S.

— Seal catching for oil is being pursued on the Point Reyes side of Tomales Bay, California, the average yield being about five gallons to the seal, worth fifty cents per gallon.

SCIENTIFIC SERIALS.[1]

THE GEOGRAPHICAL MAGAZINE. — July. The Arctic Expedition, xvi. Work of the Auxiliary Sledge Parties (with a Chart of Archer Fiord, and Plan of Petermann Fiord). The Himalayan System, by F. W. Saunders (with Map of the Himalaya and Tibet, — a View of the Mountain System bounded by the Plains of India, Gobi, China, and the Caspian). The India-Rubber Trees in Brazil, by R. Cross.

JOURNAL OF THE ACADEMY OF NATURAL SCIENCES. — Vol. viii., Part 2. 1876. On the Batrachia and Reptilia of Costa Rica, by E. D. Cope. On the Batrachia and Reptilia collected by Dr. J. M. Brandsford during the Nicaraguan Canal Survey of 1874, by E. D. Cope. Report on the Reptiles brought by Prof. J. Orton from the Middle and Upper Amazon, and Western Peru, by E. D. Cope. Note on the Ichthyology of Lake Titicaca, by E. D. Cope. A Descriptive Catalogue of the Scalidæ of the West India Islands, by O. A. L. Mörch.

CANADIAN NATURALIST, viii. 5. — Notes on some Geological Features of the Northeastern Coast of Labrador, by H. Y. Hind. New Facts relating to Eozoön Canadense, by J. W. Dawson.

ANNALES DES SCIENCES NATURELLES, ZOOLOGIE. — June 15. Études monographique sur les Assiminées européennes, par M. Paladilhe. Études sur les Bryozoaires entoproctes, par M. Salensky. Mémoire sur l'Appareil musical de la Cigale, par G. Carlet.

MONTHLY MICROSCOPICAL JOURNAL. — July. Thermo-Dynamic Origin of the Brownian Motions, by J. Delsaulx. An Explanation of the "Brownian" Movement, by W. N. Hartley. An Essay on the Classification of the Diatomaceæ, by P. Petit. The Histology of the Island of Reil, by H. C. Major. The Microscopes at the American Exhibition, by J. G. Hunt. Opaque Objects with High Powers, by G. W. Moorehouse. A Simple Form of Mechanical Finger for the Microscope, by G. Hawks.

AMERICAN JOURNAL OF SCIENCE AND ARTS. — August. Notes on the Internal and External Structure of Paleozoic Crinoids, by C. Wachsmuth. Relations of the Geology of Vermont to that of Berkshire, by J. D. Dana.

BULLETIN OF THE NUTTALL ORNITHOLOGICAL CLUB. — July. The Birds of Guadalupe Island discussed with reference to the present Genesis of Species, by Robert Ridgway.

THE POPULAR SCIENCE REVIEW, London. — July. Studies amongst Amœbæ, by P. M. Duncan. Notes on the Geographical Distribution of Animals, by W. F. Kirby.

ERRATUM. — Page 350, in the division under "North America. — East Coast," for *Metanhock* read *Metauhock*, and for *Suckanhock* read *Suckauhock*; these errors occur thrice.

[1] The articles enumerated under this head will be for the most part selected.

THE

AMERICAN NATURALIST.

Vol. xi.— OCTOBER, 1877.— No. 10.

NOTES ON THE SURFACE GEOLOGY OF EASTERN MASSACHUSETTS.

BY W. O. CROSBY.

THE prevalent line of strike in Massachusetts, as is well known, is north and south, and in the western half of the State there are no exceptions of importance to be noted. East of the Nashua Valley, however, a northeast and southwest strike prevails, especially in Essex and Middlesex counties; a comparatively limited area in the southeastern part of Worcester County exhibits a strike at right angles to this, or northwest and southeast; while among the Primordial and Carboniferous strata, a nearly east and west strike is most common.

"Geology is revealed in topography," and these fundamental structure lines find distinct expression in the leading topographic features of the State. In the Connecticut Valley and Berkshire County, where the geologic structure is simplest, this correspondence between geology and geography is most marked, and is observable not only in the grander features, — such as the Taconic and Hoosac ranges of mountains, and the Housatonic and Connecticut rivers, — but may also be readily traced in the courses of most of the minor streams and subordinate surface reliefs. East of the Wachusett range of highlands, we find, with greater complexity of geologic structure, two general topographic trends. The more prominent of these shows a close conformity with the prevalent strike, — northeast and southwest, varying toward east and west; while the other coincides with the transverse strike and the known direction of glacial movement.

Water and ice are the principal agents by which the topography of this region has been fashioned. Now there is little room to doubt that the sculpturing done by water exhibits, on

the whole, a closer correspondence with geology than the reliefs shaped by the action of ice. This results from the essential unlikeness in modes of action of the agents in question. The topographic work done by rivers is effected mainly through degradation.

> "Time but the impression deeper makes,
> As streams their channels deeper wear."

The rivers of this section seldom deposit much material along their courses, and the detritus delivered at their mouths is usually transported to a greater or less distance, and finally laid down by the sea; so that this process, although the opposite of degrading, is more marine than fluvial. The action of the sea in modifying the contour of the land, on the contrary, is, generally speaking, twofold: degradation, which, when the waves work upon rocky shores, is determined more or less in direction and amount by the geologic structure of the degraded land; and building up, which operates by the transportation of loose materials and their accumulation at particular points, and depends mainly upon the direction and force of ocean currents, tidal waves, and prevailing winds, and upon the general shape of the land and ocean bed, though quite independent of their geological constitution, except mediately in so far as this has determined their form. In this region, such features as the outer end of Cape Cod, portions of Nantucket, the southeastern part of Martha's Vineyard, part of the coast of Essex County north of Cape Ann, and Lynn, Nantasket, and Duxbury beaches appear to be due to the constructive action of the sea; and of course they can be expected to conform in trend only imperfectly, if at all, with the features produced by degradation. The close correspondence between their forms and structure usually observable in those topographic details fashioned by the degrading action of the sea or rivers is, no doubt, largely due to the mobility of the water. It is by virtue of this wonderful property that the ocean possesses a power of discrimination, — a sort of tactual sense, as it were, — which enables it to act differently upon rocks having unlike constitutions, and thus, in effect, to dissect a rocky coast in a manner analogous to the unlocking of the molecular structure of a mass of ice by a transmitted beam of light. In striking contrast with this is the action of a large land glacier, such as exists at present in Greenland and Antarctic Land, and probably spread over New England at the time when the phenomena — drift and striated

and polished rock surfaces — commonly ascribed to glaciation were produced. The comparative immobility of a large glacier causes it to move almost as a unit, and, "strong in solid singleness," it can be swerved by none but the largest reliefs, especially in a region of gentle slopes and low altitudes like Southeastern New England. So that generally, only in so far as the fashioning of these reliefs has been determined by their structure can the progress of the ice-cap be regarded as influenced by the geological constitution of the land over which it moves. Hence we are led to conclude that surface lineaments resulting from a wide-spread glaciation will exhibit great uniformity of trend over wide regions, and a general independence of the structure of the subjacent rocks; and such is conspicuously the fact in Eastern Massachusetts.

There are perhaps no surface features which are more clearly the product of glaciation than the lakes and ponds found, and as a rule found only, in glaciated regions, and which abound in New England. The great extent to which regions which have been subjected to the action of an ice-sheet are distinguished by the presence of lake basins becomes more apparent when we reflect that, as has been pointed out by Professor N. S. Shaler, these basins are probably much fewer and smaller now than when first formed at the close of the glacial epoch; for "there are in operation in the regions characterized by glacial lakes no forces capable of producing such depressions; on the contrary, all the forces at present in action tend to obliterate the existing basins." Professor Shaler has called attention also to the facts that these lake basins seldom, "except the smallest, present any approximation to a circular figure;" and that "the major axis has usually a north and south trend." The following data (derived from approximate measurements, made on good maps, of the ponds and lakes of Eastern Massachusetts) show, among other things, how general is this elongation in a north and south direction. Two hundred and ten basins were measured, including all but the very smallest, in that portion of the State east of Worcester. The mean direction of all the major axes is about N. 5° W. The mean ratios of the major axes to the minor axes is 2.5; that is, the ponds are, on an average, two and one half times as long as broad. The average trend of the longer diameters, it will be observed, coincides very closely with the mean direction of the glacial striæ of this region, and the courses traversed by erratics. In only thirty of the two hundred

and ten basins measured does the direction of the major diameter vary more than forty-five degrees from the general average, N. 5° W.; while ninety, or nearly one half the whole, deviate less than ten degrees from it, and only thirteen are found falling within ten degrees of a direction at right angles to the mean, or N. 85° E. The mean ratio of the major to the minor diameters for these ninety ponds is 2.4; but for the thirteen it is only 2. The extreme range of the glacial striæ of Eastern Massachusetts, according to Professor Edward Hitchcock, is from N. 5° E. to N. 55° W., — sixty degrees; and it is found, on examination, that the courses of fully two thirds of the ponds lie within these limits.

Terminal moraines appear to have been formed at very infrequent intervals in this region; the Elizabeth Islands, however, constitute a fine example of such a moraine, rendered conspicuous by its isolation; and others are known to exist inland. Wherever occurring, they must, of necessity, have approximately east and west trends, and bodies of water bordered by them will share the same course. In this way I conceive we may account for some of the extreme deviations from the mean trend observed among the lake basins. This explanation fails in many cases and yet these offer no special difficulty, for a more detailed consideration of our data shows a slight dependence of the phenomena in question on the general plan of the geologic structure of the region. Thus, in Essex, Middlesex, Norfolk, and Bristol counties, and all but the southeastern part of Plymouth County, where the predominant strikes among the rocks are east and west and northeast and southwest, we find the average relative dimensions of the ponds expressed by the number 2.3: while in the eastern half of Worcester County, where the prevailing strikes range from north and south to northwest and southeast, that is, are generally parallel with the line of march of the ice-sheet, the ratio of the average length to the average breadth has the comparatively high value of 3.15. Hence, we see that, while the lacustrine depressions are, as a nearly universal rule, elongated in the direction of glacial movement, the amount of this elongation is sensibly less where the progress of the ice-cap was transverse to the general strike of the underlying rocks than where it coincided with the strike. Another fact brought out by a comparison of these data has the same significance, namely: the deviations from the mean trend of the basins are fewer and smaller where the direction of the glacial motion

coincides with the strike of the rocks than where it is transverse to the strike. Thus, in Essex and Middlesex counties the trends of one half the ponds deviate more than twenty degrees from the mean, while in Worcester County the proportion is only one fourth.

One of the most remarkable facts in the distribution of glacial detritus, or drift, in Massachusetts is the comparatively great depth to which it has been accumulated over the southeastern portion of the State. There is a marked paucity of rock outcrops in the southern half of Plymouth County; south of Plymouth and east of Middleborough they are rarely met with; and Barnstable County is absolutely destitute of them. It is not improbable that the solid rocks in this region are so deeply buried by the unconsolidated superficial deposits that if the latter were removed, the whole of Barnstable County and a considerable part of Plymouth County would be invaded and covered by the sea. Professor Edward Hitchcock, in discussing this subject, estimated the maximum depth of the drift in this region at not less than three hundred feet; and he evidently believed it to exceed this. Certainly here, if anywhere, we may expect lake basins and river valleys to exhibit in their forms and trends a complete independence of the underlying rocks. This expectation is justified by the facts. There is not in the region under consideration a stream of any considerable size that has not a north and south course, although the strike of the underlying rocks undoubtedly approximates east and west. As a result of this parallelism of the water-courses, we find no streams of any importance cutting the north and south coast-lines; the western shore of Cape Cod Bay between Elisha's Point and Scusset Harbor is almost unbroken by debouching streams, and Buzzards Bay receives not a single tributary from its eastern shore. Coast-lines transverse to the direction of glacial action, on the contrary, are fretted with river mouths and long, fiord-like bays and inlets, as the northern shore of Buzzards Bay and the southern coast of Falmouth. The evidence from the lake basins is almost as unequivocal as that from the rivers. Measurements of all but the smallest basins between Orleans and a curved line extending from Kingston southerly to the mouth of Wareham River, convex to the west and including Simpson's Pond, give north and south as the average trend or direction of the major diameters, and 2.7 as the ratio of the length to the breadth, or the mean elongation.

A comparison of the lacustrine depressions of this region of excessive drift with those of Worcester County, on the one hand, and of Essex, Middlesex, Norfolk, Bristol, and Northern Plymouth counties, on the other, shows that the value of the mean elongation in the former district, 2.7, is intermediate between the values of the same property in the two latter, 3.15 and 2.3, respectively. And thus we are brought to the following general conclusion: where the drift is so deep that the forms of the lake basins have no necessary relation with the subjacent rocks the mean elongation of the depressions is greater than in districts where, the detrital sheet being thinner and less universal, the basins are partially rock-bordered, — when the progress of the ice-cap was transverse to the general strike or structure lines of the rocks, — and less when this movement coincided with the strike.

The reliefs of this region are, for the most part, of very moderate altitude; and, in consequence of the sharper contrast between land and water than between hill and valley, they are seldom represented on maps with even an approximation to the accuracy characterizing the delineation of water-bordered contours. Hence it were futile to attempt to discuss our hills and ridges in the same manner as the lake basins and river valleys. Fortunately, however, the general facts are so plain that they do not require this for their elucidation. It is in the experience of most observers in this region, that the drift hills have usually a lenticular outline, are more or less ridge-like, and that both hills and ridges coincide in trend with the direction of glacial movement. Those remarkable drift ridges in Essex County, described by Mr. G. F. Wright, and extending with a nearly rectilinear course from beyond the New Hampshire boundary to Massachusetts Bay, exemplify in a striking manner the form, trend, and general independence of geology characterizing our drift topography. Elevations composed mainly of rock *in situ*, on the contrary, express in their forms and trends the leading geologic structure lines of the region, but do not admit of correlation with the course of glacial action. The Wachusett range of highlands, the parallel range forming the eastern rim of the Nashua valley, the somewhat irregular belt of hills extending from Cape Ann to Beverly, the well-known range sweeping with a bold front from Swampscott to Waltham, and the Blue Hill range in Milton and Quincy are good examples of the more prominent and general of our rock reliefs. The first

two are fashioned from stratified rocks, and are more regular and distinct than the others, which are for the most part composed of unstratified rocks. Yet the latter, no less than the former, reveal the structure of the rocks composing them; for exotic rocks, being, in a certain sense, structureless, only conform with the general law in giving rise to a systemless topography.

The notion appears to be gaining ground among geologists that the power of a continental glacier to degrade the surfaces over which it moves, or, at least, to alter the forms of those surfaces, has been greatly over-estimated. It has become unnecessary, in the light of recent investigations, to ascribe to the active agent of the drift epoch, whether land-ice or icebergs, great abrading power in order to account for the formation of the truly immense and generally chaotic mass of superficial detritus constituting the drift; for in the subaerial decomposition of rocks, especially crystallines, *in situ*, during immense periods of time, we have a process fully competent for the production, both in quantity and quality, of the detrital materials, including bowlders, found in glaciated regions. The real degradation, the formation of the detritus, is mainly the work of chemical and not of mechanical forces. The sheet, usually thirty to forty, sometimes fifty, and even one hundred feet in thickness, of thoroughly decomposed materials passing insensibly into solid rock below, found over a large portion of the Southern States, and occurring generally wherever there are crystalline rocks in low latitudes, is a substantial monument to the degrading power of these silent agents, which are doubtless still in operation. As a nearly universal rule, we find the drift in New England reposing upon smooth and polished surfaces of undecomposed rocks, which evinces that the glaciating agent had sufficient erosive power to sweep away all traces of the zone of partially decomposed, semi-rock-like material that in the South intervenes between the firm rocks below and their decomposed skeleton above, and which probably existed over glacial latitudes in preglacial times. The theory of subaerial decomposition so far diminishes the erosive power required, by previous hypotheses, in the agent of glaciation as to render possible a reconciliation of the existence of an ice-cap in quite recent geologic time with the well-known fact that many reliefs of comparatively small magnitude have trends and contours wholly at variance with the courses of glacial movement, and incompatible with the supposition that the ice-sheet moved as a rigid, unyielding rasp, removing hundreds of feet of solid rock from the surface of the country.

It appears probable that but few of those surface unevenesses which are impressed upon the rocks have had a glacial origin. At any rate, a large number, including all the more important, of these rock-impressed inequalities of the surface in this region are doubtless much older than the glacial epoch which has but recently passed away, and, if due to glaciation at all, were sculptured during some earlier reign of ice. Such large rivers as the Merrimac, Nashua, and Blackstone are unquestionably of preglacial origin. Their courses are parallel with the strikes of the rocks over which they flow; and the first two, at least, occupy well-marked geological valleys. Furthermore, it is hardly conceivable that glaciation can have been the cause of rock-bordered valleys transverse to its line of action, as is the Merrimac in Massachusetts; and the valley of this stream, so far from being the product of glaciation, probably exists in spite of the tendency of the ice-cap to obliterate it.

The question, also, as to what extent the so-called fiords of this region are due to the excavatory power of ice during the last glacial period can hardly be regarded as settled. Reference is made, of course, only to fiords carved from the solid rock, which is not the case with those in Barnstable County. The fact that these inlets are chiefly found on coasts transverse to the direction of glacial movement becomes, I think, less an obstacle to the denial of their glacial origin, when we reflect that the tendency of an ice-cap would be to fill up and obliterate such coastal inequalities as were transverse to its line of progress, and at the same time to clean out such as coincided with its march. If the superficial deposits were removed from the New Hampshire coast, the northeastern part of Essex County, and Eastern Plymouth County, it is not improbable that these north and south shores would present irregularities nearly as marked as those that indent our southern coast.

It is a significant fact that the northern shore of Massachusetts Bay, though parallel with the northern shore of Buzzard's Bay, and hence similarly related to the course of glacial action, is destitute of conspicuous indentations that can be regarded as the work of the ice-sheet; for all the important rock-bordered deflections of this coast-line have their major axes transverse to the line of march of the glacier. Marblehead harbor is one of these northeast and southwest troughs; and here we have evidence of a unique and conclusive character, proving beyond question its preglacial origin. This strait — for such it would be

but for the bar across its southwestern end — is a well-marked depression, and has clearly been formed by the erosion of the ancient Huronian granite, petrosilex, and diorite, by which it is bordered. Near the middle of the southwest side of the harbor, visible only at low tide, is a hard, whitish, fine-grained sandstone or arenaceous slate. It overlies unconformably the banded petrosilex found on this shore: the petrosilex dips steeply to the southeast, while the sandstone has apparently, a gentle dip in the opposite direction. Interposed between the petrosilex and sandstone is a thin stratum of conglomerate, composed of pebbles of the former. Obviously, Marblehead harbor was excavated before the deposition of this sandstone, which can hardly be newer than the Carboniferous period, and is probably coeval with the Primordial rocks in the vicinity of Boston. Other remnants of the sandstone are scattered over Marblehead neck, in such positions as to indicate that the granite and petrosilex of which the neck is mainly composed have suffered but little erosion since the formation of the sandstone. The removal of the sand-rock from the harbor, which it doubtless once filled, may have been the work of ice in recent geologic times; but the harbor itself must have had substantially its present form before the close of the Palæozoic era. Salem, Beverly, Manchester, and Gloucester harbors have also been cut out of Huronian or still older rocks; and, when we consider their striking resemblance in form and trend to Marblehead harbor, it is difficult to avoid the conclusion that they have an antiquity equally great.

The limitation of fiords to high latitudes and to coasts favored with an abundant precipitation of moisture (usually western coasts), that is, to coasts most favorable for the formation and development of glaciers, certainly appears a sufficient warrant for the commonly accepted opinion that these deep, narrow, and ofttimes tortuous channels are the product of glacial erosion, the more especially since fiord valleys usually exhibit, in the form of moraines and striated and polished rock surfaces, unmistakable traces of the former presence of glaciers, and in some regions are occupied by existing ice streams. Yet this theory fails most signally to adapt itself to some phenomena of an important and general nature. Mr. James Geike, in The Great Ice Age, says that some of the fiords of Great Britain are known to date back to the Devonian age, and that, though many may have been deepened by ice action during the last and earlier glacial epochs, they were *all originated by streams and rivers in*

ages long anterior to the Post-Tertiary ice time. Valleys must precede valley-eroding glaciers.

From our remote northwestern coast we have yet more conclusive testimony to the preglacial origin of the phenomena in question. In no region, save perhaps the western coast of Norway, is there a grander development of fiords than on the Pacific coast of North America, from the labyrinth of Vancouver Island northward. These fiords are cut in the seaward slope of a bold mountain range, bearing the lofty peaks of Fairweather and St. Elias. According to Mr. W. H. Dall, almost every fiord of considerable size on this coast, especially toward the north, "has at its head a glacier, or the remains of one. Some of these glaciers are of extraordinary size and grandeur."[f] The same authority states that evidence is wholly wanting that these glaciers ever much exceeded their present limits. The walls of the fiords, short distances below the present terminations of the glaciers, are not smoothed or striated; and no terminal moraines stretch across the fiords, or form shoals at their mouths. These are typical fiords, and yet the evidence that they are not due to the action of ice in any recent geologic time is rendered conclusive by the occurrence in some of the fiords having glaciers at their sources, according to Mr. Dall, of islands composed of soft and yielding Tertiary strata, which must have been completely swept away had the ice streams ever filled the gorge. The existence of these Tertiary beds is a certain indication that the fiords antedate that period, and hence they are, in a certain sense, the cause rather than the consequence of the present ice streams.

The tendency of the considerations here presented is evidently toward the view that, comparatively speaking, the ice-cap rested lightly upon the land, and that the topographic features having a skeleton or frame-work of rock are, as a rule, of preglacial origin. In other words, it appears probable that if the present mantle of drift were entirely removed from the face of the country, leaving a surface of naked rock, we should have in all important respects a restoration of the anteglacial contours. And this ancient topography having been, as I conceive, fashioned mainly by agents more subtle than an ice-cap, and hence taking a deeper hold on geologic structure, would if thus undisguised reveal a closer correspondence with the structure lines of the subjacent rocks than we are able to detect in the existing hills and valleys considered as a whole.

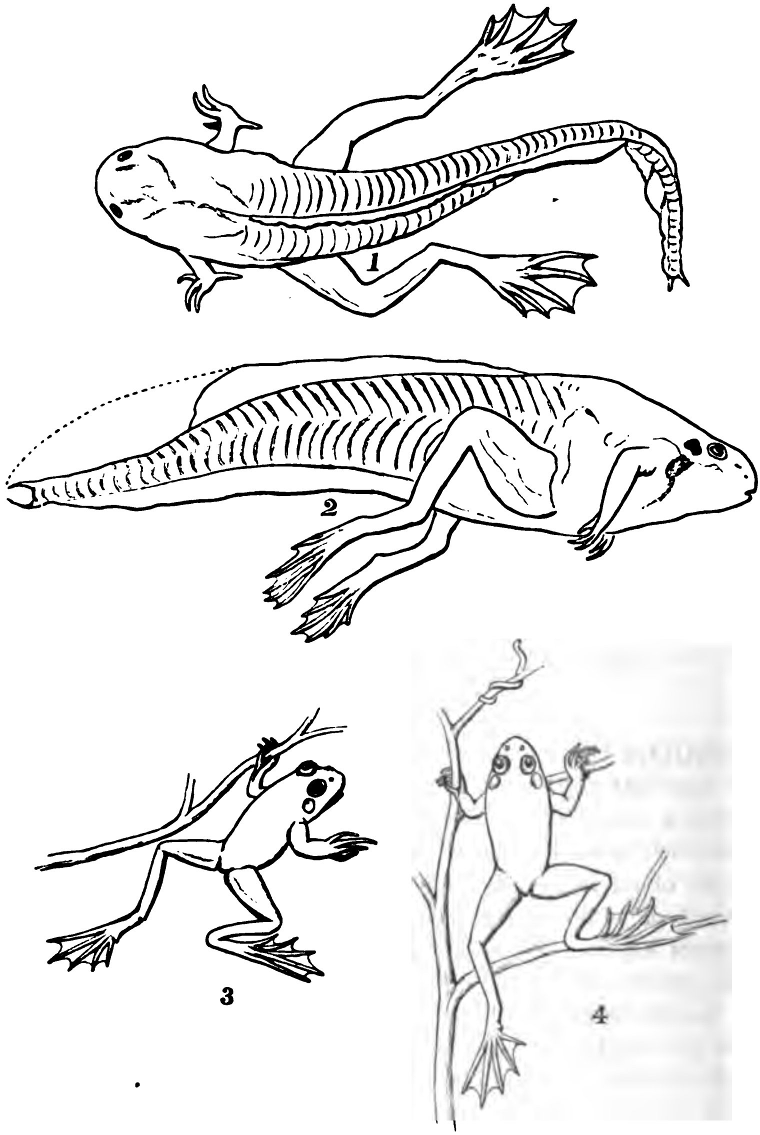
The uniformity of trend in glacial striæ and drift transportation observable over wide regions appears inconsistent, at first view, with the supposition that the ice-cap had but little erosive power: a contradiction seems implied in the possession by a glacier of a magnitude and rigidity which enabled it to move without deviation over prominent reliefs, and a general inability to erode those reliefs. How can we harmonize the lightness of its tread with its rectilinear march over uneven surfaces? That ice in glacier masses behaves essentially as a very viscous liquid is well known; and a solution of the problem is found in a peculiar condition, pointed out by many writers, and necessarily existing in a continental glacier, which limits the freedom of motion among themselves, possessed by the different portions of the ice-sheet, to a vertical direction. Lateral deviation is rendered impossible by the inferior plasticity of the ice; and hence, when any portion of the ice-sheet encounters an obstacle, around which it would flow if sufficiently fluent, it is found easier to overcome the gravity of a small mass of ice than the cohesion of a relatively large mass, and the ice, moving in the direction of least resistance, passes in a vertical plane over the obstruction.

PSEUDIS, "THE PARADOXICAL FROG."

BY S. W. GARMAN.

PSEUDIS is a peculiar South American frog, peculiar in the fact that it grows smaller as it becomes adult, and in possessing a nearer approach to a thumb than any of its relatives. It is much to be doubted whether there is anything in the actual history of an individual belonging to this genus that calls for an amount of notoriety to which the most common toad or frog may not aspire. To be sure, the tail is kept long after all the legs appear; the tadpole is larger than the adult, and the creature has a hand in which the thumb is opposed to the three fingers, yet all these are hardly enough to demand the amount of attention of a certain kind which the genus has received. In fact, as often happens in the case of men, Pseudis owes much of his reputation to a mistaken estimate. If we might trace him from as early a period as men have seen until well advanced in life, we should probably see nothing more than takes place in the history of all batrachians. We might meet the egg first coming within the limits of our vision as a round, granule-like body be-

tween the cells of the corpus graffianum in the ovary. It would gradually acquire a membranous covering and a germinal vesicle



(Fig. 97.) PSEUDIS.

1, 2, Batrachichthys, from Ann. Mus. Nac. Rio de Janeiro, Vol. I., Pl. VI.
3, 4, Pseudis minuta, from Nature.

with the inclosed germinal dot; or, better stated according to Agassiz's nomenclature, it would appear as an ectoblast contain-

ing a Purkinjean vesicle (mesoblast), within which rests a Wagnerian vesicle (entoblast). If we were to follow the egg closely through its different conditions we should see it dropping from the ovary at maturity, passing to the mouth of the oviduct, and through it thrown out into the waters at the same instant that it receives the life-imparting sperm from the male.

If Newport did not mistake, we might see the snake-like spermatozoön work its way through the envelopes to the surface, where, breaking into granules, its identity is lost in the substance of the yelk. Then we should notice the beginning of segmentation, its progress, and the successive changes of form in the embryo, until it tears the shell, and with great, wondering eyes stares out upon its watery world a tadpole. While a big-headed slender-tailed tadpole we should find much of interest in the *Jackie*, as called at home, but in the main the story might be told with approximate accuracy from one secured in the nearest pond. After leaving the shell his manner of life would resemble in most respects that of any other passing through the same stages. He might be seen at one time busily engaged grubbing along on the bottom for whatever eatable might come in his way (and he is not at all particular as to his food), or with many companions lying quietly at rest, starting every now and then like the Turk from his dream, rushing frantically to the surface for a mouthful of air, then tearing back as if his very life depended upon haste, placing himself on the mud as before, just as if nothing whatever had happened. At another time, with a whole group of his fellows, he would be seen to start upon an extended migration as though he had determined to leave the scenes of his youth forever behind him. Often he might be observed to gnaw for some moments at the sides of the leaves of the water-plants, all the while wagging his tail and appearing as jolly as if he had as much real enjoyment in eating as a pig or dog. Then again he would be seen to take a nap with his nose just against the surface of the water, and on being waked suddenly to bury himself deep in the ooze below.

But all the time he would have nothing in the world to do but eat and grow and keep out of the way of hungry enemies. He would eat to some purpose and grow to a size considerably greater than that of the adult. In the mean time the hind legs, with the broad-webbed feet appear, and the arms and hands with the peculiar thumbs. Here he rests for a time as if altogether uncertain whether further change is for the better. In fact, he

loses by the next change, for when it has passed he is smaller than when it began.

His first mention in literature takes him up at this period. Through some Dutch collectors in Surinam, Albert Seba secured specimens of the adult and of the large larvæ with and without limbs. Comparing the smaller with the larger he came to the conclusion that the development was retrograde: that the animal was first a frog, then acquired a tail, then lost its limbs, and finally — the remote resemblance between the coils of the intestine and the sucking disk of the gobies probably suggesting the idea — became a fish. His conclusions with sketches were communicated to Mlle. Marie Sybille de Merian, who published them in her work on the Insects of Surinam, citing Seba as the source. The latter published the same a few years later in his Thesaurus (volume i., plate 78, 1734), where he gives a series of figures illustrating the transformation of the frog into the fish. This version of the story was at first accepted by Linné (Mus. Ad. Fridr., 1754) and by Edwards (Phil. Trans., volume li.). In the tenth edition of the Systema Naturæ (1758–59) Linné corrects the matter, and the name *Rana piscis* of Merian gives way to *Rana paradoxa* Linné. From that time until within a year the "frog-fish" seems to have known his place. Wagler, in 1830, applied the name *Pseudis*, on account of the errors into which the early observers were led, and the genus then established under this title has been generally accepted by authors.

Last year a chapter was added to the history of the "paradoxical frog," which refers us back to the beginning. Page 31 of the *Archivos do Museu Nacional do Rio de Janeiro*, volume i., 1876, second and third trimesters, contains an article with this title: Nota descriptiva de um pequeno animal extremamente curioso e denominado Batrachchythis, by Dr. Pizarro. From the description and the figures on plate vi., it is not difficult to recognize our old friend the young Pseudis, of whose peculiarities the doctor does not seem to have been aware. There is little doubt that *Batrachichthys* — to whom the author calls the attention of Messrs. Darwin, Haeckel, and Martins — will ultimately go through his transformations, become a veritable Pseudis, and be degraded from his position as connecting link between fishes and batrachians. Should he go no further, as is barely possible, he would even then be only a link between the adult and the tadpole, and no more closely allied to the fishes than either. In this case, which is only a supposition, his standing

would be to the frogs just what that of the axolotl is to *Amblystoma.* What information the author has given us with the description and figures of the single specimen that has come to his notice will not allow the assumption that the representatives of the genus in Paraguay differ from those in Surinam in respect to the length of time passed in the larval stage. It is well known, however, that in other batrachia the metamorphosis can be hastened, or retarded, or prevented, as may be desired; that the time varies in different seasons and localities according as they may be favorable or otherwise; and that in species of a single genus, as *Rana*, the metamorphosis occupies weeks in some cases, years in others. Dr. Jeffries Wyman is said to have kept larvæ of the bull-frog seven years, more than twice the ordinary period of existence of the animal in the larval stage. More information concerning the species of Pseudis (*P. paradoxa*, *P. minuta*, and possibly a third for *Batrachichthys*) is desirable.

A little exercise of imagination enables one to see them grasping and swinging from the branches of the plants by means of the opposable thumb; whether this is its use is a question. One can imagine the tail and feet both required in the pursuit of rapidly moving prey or in escape from lively enemies, but it is only supposition.

However, we shall wait another chapter in the history before accepting *Batrachichthys* as one of the "missing links;" the reputation of Pseudis as a deceiver is too well established.

ON THE ANCIENT AND MODERN PUEBLO TRIBES OF THE PACIFIC SLOPE OF THE UNITED STATES.[1]

BY EDWIN A. BARBER.

IN the far Southwest, covering far the greater part of that section of the United States now known as Colorado, Utah, New Mexico, and Arizona, and stretching through the great valleys of the Rio San Juan and its tributaries, the Colorado and the upper portion of the Rio Grande del Norte, there exist the ruins of thousands of stone structures, built by a prehistoric race whose individuality has been lost in the obscurity of past ages. The great extent of territory which the remains cover, and their great number, would indicate a former population of at least half a million souls.

[1] Read before the American Association for the Advancement of Science, at Buffalo, 1876.

At the present day there are two tribes of semi-civilized Indians in New Mexico, known as the Pueblos and the Zuñis. These people live in permanent stone houses which resemble closely in architecture the deserted ruins to the north. In the northeastern part of Arizona, situated in longitude 110° to 111° west, and latitude 35° to 36° north, are the seven towns of the Moquis, a tribe closely allied to the Pueblos and Zuñis, and doubtless a branch of the same ancestral stock.

The object of this paper is to give some facts which will help to prove that the ancient people with whom originated the ruins of this section were the ancestors of the three house-building tribes just mentioned.

The question which first presents itself to our minds is, *Who were the architects of these ancient and extensive ruins?* In striving to solve this problem, let us in the first place glance at a few of the traditions of the barbarous tribes which occupy this portion of North America. Although traditions and legends are by no means data from which to draw conclusions, nevertheless they may be of interest in this connection, as showing the ideas which the present Indians of the West entertain in regard to these ancient ruins and their creators. Moreover, we can detect in many of these "imaginings" a remarkable similarity through different and widely separated tribes, which fact lends to them at least a semblance of probability.

The Moquis of Arizona profess to have among them an ancient tradition which runs in this wise: The entire country covered by ancient habitations was occupied long ago by a peaceful, agricultural, and pastoral race, from the time the earth was but a small island. Here they flourished and multiplied for many generations, tilling the soil and raising flocks and herds along the fertile river valleys. After a time another tribe, uncultivated and barbarous, came down from the north to visit them.[1] The people received them kindly and treated them in a hospitable manner, and their visits grew more frequent. Finally they became annoying and showed a warlike spirit. The owners of the land then fled to the cliffs, and subsisted as best they could, until the barbarians from the north came down with their families and settled permanently, driving their victims from the country. Then the persecuted people gathered together once more at the *Cristone* (a needle-shaped spire of rock on the San

[1] These latter were undoubtedly the ancestors of the Utes and other savage tribes which formerly occupied that section.

Juan River). Here they built houses in the caves and cliffs; erected fortresses, watch-towers, and store-houses; and dug reservoirs to supply themselves with water. After a prolonged battle their enemies were repulsed; but the conquerors retired to the deserts of Arizona and settled on the high bluffs of that region, where their posterity, the Moquis, live to this day.

Accounts of this people, orally transmitted from father to son, exist among the Ute Indians of Southern Colorado, to the same effect. They claim to be the descendants of the race which conquered the builders of these pueblos. They evidently believe that the architects were ancient Moquis, and if asked who originated these ruins will invariably answer, "Moquitch." I had some curiosity in regard to the opinions of the Ute Indians on this point, and availed myself of every opportunity to make inquiries. I asked one old warrior who built the houses around us, and his reply was, "Moquitch." Of another who sat watching us intently as we made some excavations, I inquired what people were buried here, to which he answered, as usual, "Moquitch." From several Indians of separate bands I received the same reply in regard to the pottery, arrow heads, etc., and I soon discovered that this was at least the prevalent belief throughout the whole tribe.

The Navajos are said to possess traditions of the same nature relative to the aboriginal people; but I was unable to gain any information from those we met in Arizona.

I am led to think from the many evidences which are presented to us that the original people retired from the north southward. This supposition agrees with the traditions of the natives and is supported by the general appearance of the remains. Those farthest north are in the greatest state of decay, while as we advance southward they are much better preserved. Through New Mexico and down into the southern part of Arizona the ruins of buildings and pottery possess a more recent appearance, and there can be no doubt that these (south of the Pueblos, Moquis, and Zuñis) are, to a certain extent, of *comparatively* late date, extending back, perhaps, only to about the first quarter of the sixteenth century, when the Spaniards marched across the country. Many of the ruins along the Gila and in the neighborhood of the Pueblo tribes of New Mexico are simply the remains of a century or two, although in *some* localities they are much older. There can be not the least doubt, however, that all north

of the Rio San Juan, and those to a certain distance south, are of exceedingly great antiquity.

On visiting the seven Moqui villages after passing through the ruins of Southern Utah and Northern Arizona, the archæologist is first impressed with the remarkable similarity which exists between the architecture, utensils, and implements of the ancient and modern peoples. The architecture of the Moquis, especially, resembles strongly that of the ancient Pueblos. The houses are very ancient, and were built certainly more than four centuries ago, as they were found by the Spaniards about the years 1539–1541, in the same condition, almost, as they are now. At that time they had been occupied for years, and north of them the same buildings which are now crumbling in ruins were deserted. The Moqui towns were known to the discoverers as the "Province of Tusayan." The houses are made of stone, after the manner of the ruins, the walls being massive and squarely built. The stones are laid in adobe mortar without lime, and the walls are plastered externally and internally with mud, which has given some explorers the erroneous idea that they are adobe structures. Space will not permit me to enter into a description of the architecture and an exhaustive comparison of the methods of building of the two different periods of time. The general form of the Moqui houses is identical with that of the ancients, and the materials used are the same in both cases. Both were generally approached by ladders, and the more recent Moqui buildings were built on high mesas, just as the older structures were usually set in the cliffs and caves, for protection from enemies.

In general form and appearance the earthenware of the two ages corresponds. The process of manufacture was the same in both, and the resulting utensils vary but slightly in any respect. To be sure the modern ware is inferior in quality to the ancient, and lacks that finished glazing which characterizes the latter. The same geometrical designs are common to both, and are painted in colors, usually black, red, yellow, or white. Among the ruins the fragmentary pottery is very abundant, being scattered over hundreds of miles of country. For each ancient form of vessel a corresponding one may be found in the modern Moqui ware. It may be argued by some that the Moquis did not inherit the art from the ancients, but simply imitated in shape and finish the numerous specimens which still remain of the old Pueblos. This, however, seems not at all probable, for the Moquis seldom leave their own towns, and few, if any of them, have ever visited those ruins which abound in this ware, along the San Juan River.

The art is an ancient one and has undoubtedly been handed down from generation to generation, with few modifications or alterations, and no improvements. It would be a very singular circumstance if this particular tribe should pattern after an earlier race (having no connection with it), while the other tribes of this section, as the Utes, Navajos, Apaches, etc., though living to a great extent *in* the very ruins themselves, and still practicing the art of molding clay, do not imitate the ancient pottery, but possess their own peculiar methods.

The most common stone implement to be found among the *débris* of the ruins is the corn-grinder or rubbing-stone, which in form is long and flat, made of sandstone, basalt, or coarse-grained *pudding-stone*, and measuring some ten or twelve inches in length, four in width, and an inch or so in thickness at the centre. These grinders have been rubbed down by use, flat on one side and sloping on the other from the centre to the edges, giving each stone a three-sided appearance. There is another form of this tool which is usually made of the coarser-grained materials, being oblong, probably four to six inches in length, four in width, one to two in thickness, and flat on both sides. Several of these we found in a state of completeness, while of the former we found but one perfect specimen. Accompanying such objects in many of the ruins were large, square, flat stones, a foot or fifteen feet square and a few inches deep, which had been hollowed out by long rubbing on the upper surface. These were the millstones or *metates*, on which the corn was ground with the aid of the rubbing-stone. Through Southern Utah and in Arizona we found several perfect millstones and scores of fragments, which we were unable to transport on account of their great weight.

The same implements are found in use at present among the Moquis. In every house there is a series of three or four of these mills with their grinding-stones. From the presence of these among both the ancients and moderns, their modes of labor, at least, are shown to have been similar.

Great stone mortars and pestles occur among the ruins, and on the tops of the Moqui dwellings they are still numerous, though for the most part are now not used. In the centre of the open court of Tegua there is a pile of large stones, among which is a huge stone hammer or maul made of hard sandstone, measuring about a foot in length and weighing at least twenty-five pounds. This resembles closely some which were discovered among the

San Juan ruins, several of which weighed twenty pounds each. Comparatively few of the old stone implements still remain in the Moqui tribe, having been replaced by iron tools. Those which yet exist are not in use, but are kept as relics of a past age. Many of the inhabitants can recollect when metal was first introduced among them, although it had been employed among the nomadic tribes of that district for centuries.

The rock inscriptions, which are everywhere visible in the vicinity of ancient mural remains, are also found on the cliffs and walls of the plateaus on which the seven Moqui pueblos are built. These latter are very old, and the present people know nothing of them except that they were engraved there by their forefathers very many years ago. Frequently the same designs and figures are observable which adorn the rocks in the desert country to the north.

From the above brief comparisons of the productions of these modern and ancient peoples, it becomes very evident that they possessed the same customs, habits, and to a great extent modes of labor. Further than this, they were both architectural and agricultural peoples, and both paid homage to the sun, or at least looked for a Messiah daily to come to them from the east. Many of the ancient houses (as those in the cañon of the Mancos) faced toward that direction, and here the inhabitants might continually watch the eastern heavens; the Moquis still mount the roofs of their houses and wait expectant while the sun rises each day to view.

The modes of burial are also the same as formerly, except that cremation is not practiced now by the peaceful tribes as it was during times of war, centuries ago. We find no *large* mounds for the purpose of sepulture among the ruins of this section or through the Moqui burial grounds, yet the graves in both cases are marked by upright stones set on edge in the soil, and much pottery is strewn over the surface.

After briefly reviewing these facts, we arrive at the following conclusions: In the first place we know that an ancient race, agricultural, semi-civilized, and well advanced in the industrial arts, peopled this portion of the West. From the traces of once cultivated fields, now overgrown frequently by the *Helianthus*, through the river valleys, and the impressions and even the presence of corn-cobs in the mortar, and of burnt corn-cobs in burial urns, we arrive at the conclusion that the people were agricultural. That they were well along in the arts may be seen in the

proficiency to which they attained in the manufacture of pottery, the shaping of instruments and utensils, and the building of stone houses.

The original people inhabited a great extent of territory, covering many thousands of square miles, and must, at one time, have been a powerful race.

The ruins bear on their faces the impress of great antiquity, how old none can tell. Yet they were built long before those pueblos in Arizona and New Mexico, which are occupied by the present industrial tribes, and which were standing as they now are at least three and a half centuries ago, when the Spanish expeditions visited them. That the same people who built the ruins erected these more recent habitations there can be no doubt. This can be satisfactorily proved by a comparison of the architecture, implements, hieroglyphics, and other productions of labor, besides the characteristics of the people, their habits, manners, customs, religious ceremonials, etc., and we must therefore admit that they extend back, at the very lowest calculation, four hundred years, and in all probability much farther.

The modern Moquis of Arizona and their allies, the Pueblos and Zuñis of New Mexico, who dwell in towns situated to the east and southeast of the villages of the former, undoubtedly possess a common ancestry, as inferred from their similar habits and the glimpses we obtain of their ancient history. It is believed, if it be not an established fact, that those ancient ruins which are so common in New Mexico originated among the prehistoric Zuñis and Pueblos, just as those same remains which are found in Colorado, Utah, and Arizona are supposed to have been built by the ancestors of the Moquis. Therefore it may reasonably be *inferred*, at least, that the three tribes originally descended from the same ancestral stock. It consequently matters little what we call the ancients, whether Moquis, Zuñis, or Pueblos, although for convenience and on account of their architectural peculiarities, we may term them the *ancient Pueblos*, or town builders.

All through the great extent of country, once inhabited by this people, we find stone implements of every degree of proficiency of manufacture, from the rude pebble which has been picked up from the river-bank and used as a hammer to the carefully fashioned and smoothly polished Neolithic tools which are examples of a highly perfected art. But the improvement ceases here. No vestiges of bronze or iron have yet been found.

In many of the remaining walls of the ancient buildings, the

stones have been trimmed symmetrically into cubical and rectangular blocks; but it can be clearly seen upon careful examination that the work was *not* accomplished through the agency of metallic tools. In several instances where the crude cedar framework of the apertures was still preserved, or where the wooden beams projected between the stories, we noticed that the ends had been cut or hacked with blunt stone axes. Everything in the architecture of the buildings, indeed, indicated the employment of dull implements except in the masonic labor, where simply the hands of the workmen performed all the requirements of such work.

Among the pottery we found many handles of utensils which had almost invariably been hollowed out to give them as little weight as possible; and this was done, not by the use of iron or copper wires, but by means of straws and slender sticks, which left in the wet, plastic clay their perfect impressions. These were used, doubtless, for the purpose of strengthening the handles while in a plastic state.

The people were driven from the land by another powerful race, as is evident from the many indications which exist on every hand. The great numbers of arrowheads and warlike weapons in the vicinity of all of the larger structures, the quantities of shattered pottery, which in some measure resulted from the attacks of enemies, the appearance of the houses among the almost inaccessible cliffs, and the evident desire of their builders to conceal them from view by such artifices as imitating in them the texture and color of the surrounding rocks, — all these facts point to one conclusion: that the people were forced to migrate southwards by an irresistible enemy.

To *some* extent, however, extreme drought may have been instrumental in this depopulation, for there are thousands of indications that the country was at one time well watered both by running streams and springs, and by artificial *acequias*. The entire country must have undergone since its occupation a great physical change, in being transformed from a fertile, well-watered tract into a dreary, barren waste, and this alteration may have commenced toward the latter part of the existence of the ancient empire. Some time must have been required to effect this change, however, and the nation had long disappeared from its strongholds when the fountain-heads had almost entirely ceased to flow.

The Pueblo tribes of to-day are but scantily supplied with

water. In the vicinity of each town one or two small, brackish springs may exist, and these usually at the foot of the bluff, so that the labor of carrying water from the reservoirs, several hundred feet below, to the houses above occupies much time, while the liquid is highly prized and never wasted. I think this scarcity of water originated the custom of performing ablutions in water mixed with saliva and spirted from the mouth over arms and hands, and also that custom which prevails among the women, of using their saliva for mixing clay, both in plastering the walls of the houses and frequently in making potter's clay.

The Moqui people are dwindling away year by year. In the last twenty years they have decreased from six thousand to fifteen hundred, while the Pueblo and Zuñi tribes are just as surely dying out. In a short time they will have entirely disappeared, and their deserted towns will form other groups among the ruins which now dot the desert of the far Southwest.

THE AMERICAN ANTELOPE.

BY S. W. WILLISTON.

THE great plains of the West have afforded to sportsmen and tourists few more attractive features than the American or prong-horned antelope (*Antilocapra Americana*). While their habitat embraces a large range of country, extending from the Missouri River nearly to the Pacific slope, the region that is most peculiarly their home is the vast untimbered prairies of Kansas, Colorado, and Nebraska, where they have so long been associated with the other mammals so characteristic of those arid plains, — the buffalo and prairie-dog.

Since my early childhood their graceful forms and timid, startled movements have been to me familiar sights upon the Kansas prairies, and for several summers they have been daily, almost hourly, objects of my admiration.

Their peculiar habits necessarily prevent their remaining in settled regions. Unlike the deer family that find shelter in forests or rocky ravines, away from the observation of their enemies, the prong-horns seek the most conspicuous localities on the tops of hills and divides, or at the heads of ravines and the smaller water-courses, where their almost wonderful vigilance readily warns them of the approach of danger. The power of sight and the extreme wariness which these animals possess fill

even the experienced observer with fresh surprise, and the inexperienced sportsman with chagrin. The horseman riding over the trackless wilds of Western Kansas or Colorado is constantly observing, far away on the horizon, mere specks of moving life bounding away with more than the fleetness of the greyhound, till in a few moments they are lost to his gaze. Their watchful attention, ever on the alert, will notice the approach of an unusual object even before they themselves are distinguishable from the surrounding prairies. Unlike the buffalo, whose power of sight is comparatively feeble, but which will scent danger from a very great distance, the antelopes depend almost exclusively upon their acute vision for safety. I have frequently watched them, from some sheltered spot near at hand, while they have been quietly grazing: with almost every mouthful of food, cropped from the short, crisp, nutritious buffalo grass that they like so well, the suspicious animals raise their heads erect and gaze about them. This is especially true of the male, he being most frequently the first to apprise a herd of danger; he also possesses more of that curiosity that so often proves fatal. These animals, however, readily become accustomed to even the strangest objects if stationary or permanent. They will often graze quietly within a few hundred yards of a railroad station, nor even show very much fear at passing trains; but their timidity at the approach of human beings is rarely lessened. Their instinct has taught them that man is their worst enemy.

Their long association with the buffalo, of which they have not the slightest fear, renders them indifferent to the presence of domesticated cattle, with which they will mingle freely, feeding quietly side by side. It is in such cases that the hunter can approach them most easily, as they lose much of their habitual watchfulness when in large herds, whether of their own kind, or of buffaloes, or cattle. A friend — a cattle owner on the plains — gives an account of a male which became so attached to a herd of cattle that he seldom left them, and for nearly three months allowed himself to be driven about with his new-found companions, showing his instinctive timidity only at the approach of a strange herder. He finally abandoned the herd when driven to a new pasture ground.

Although so very timid in the feral state, they may be tamed with the utmost facility, evincing an unusual degree of affection for their master, or more especially their mistress. The great delicacy of their flesh as food, together with the hardiness the

animals exhibit in a wild state, renders the question an interesting one, whether the antelope might not be advantageously added to the list of domesticated animals.

When quite young, or for a few weeks or so after birth, the "kids"[1] show a strange lack of fear, and, if approached gently while lying down, will allow themselves to be caught without resisting, and after a few plaintive bleats and a little caressing will often follow their captor, nor permit themselves to be eluded! The young, which are dropped between the 15th or 16th of May and the first week in June, are almost invariably twins. For a short time previous to their birth, the doe, absenting herself from her companions, seeks a somewhat secluded spot near the head of a ravine, where her kids remain for a few days, till they attain sufficient strength of limb to keep pace with the adults. The kids are very playful, and there are few more pleasing sights presented by mammals than the gambols of these beautiful little creatures as they leap about and push each other, occasionally making their sedate mother an unwilling party in their sports. The doe frequently leaves them to graze a mile or two distant, and the kids when tired of playing with each other will find imaginary playfellows in clumps of grass or tall weeds. The friend previously spoken of relates an incident that is worthy of reproduction here. One day, leaving two quite young calves in a secluded spot, and returning in an hour or two, he was amused upon nearing them to find a doe complacently looking on while her young kids, having induced the calves to become their willing playmates, were gayly frolicking with their new acquaintances.

The young very soon attain their full stature, and by the following December are scarcely distinguishable from the adult. It is very rare that a non-pregnant female is shot in the spring, and there is but little doubt that the antelope breeds at the end of the first year. The period of gestation is apparently a little more than eight months.

From early spring till September herds embracing more than a dozen individuals are seldom seen — the males usually keeping more or less isolated. They feed upon the uplands during the day, approaching the water-courses or standing pools only later in the afternoon. At night their favorite resorts are near the heads of ravines or other secluded spots, and they frequently lie in the morning till the sun is some distance above the horizon.

[1] I use the terms, as applied by hunters and sportsmen, of "buck," "doe," and "kid," although evidently incongruous.

The bucks, and, in a less degree, the does also, possess a singular amount of curiosity strangely at variance with their habitual timidity. Any slowly moving or obscure object when seen at a short distance, for the first time, will almost invariably command their instant attention, rendering them undecided and bewildered. Either by moving from side to side in a quick startled manner, or by standing perfectly motionless with head highly erect, at the same time repeating their peculiar shrill snort or whistle, they exhibit a ludicrous mingling of fear and inquisitiveness. So long as the object keeps in sight they continue to approach, often to within a few rods; but the moment they are fully satisfied of danger, or the object disappears, they are off with the fleetness of the wind, not often stopping till one or two miles are between them and the danger. The hunter frequently takes advantage of this trait to allure his game within easy range. A fluttering cloth, the barrel of his rifle, or the hunter's heels, as he lies upon the ground, are often sufficient to attract them. One of my first experiences in hunting these animals has ever since afforded me amusement. Starting a small herd one evening, and not knowing how useless the attempt would be to follow them, I set out in pursuit. On seeing them go over the brow of a neighboring hill, I crept cautiously for several hundred yards till I reached its summit. Then rising to my feet I was myself startled by a shrill snort immediately behind me, and turning about perceived the animals gazing at me in intense astonishment but eight or ten rods away. They must have followed me for nearly a quarter of a mile as I crept along in the early dusk.

When wounded and brought to bay they rarely evince any pugnacity,—in singular contrast with the mule deer (*Cervus macrotis*) of the same regions. I have known a buck when disabled and caught to stand bleating piteously while its throat was cut. Occasionally, however, they will turn and fight with desperation, using both their feet and horns.

In the regions where they abound they decrease slowly by reason of their enemies. They are difficult game even to the professional hunter, and certainly not many fall victims to the wolves. Several times I have watched the attempts of coyotes to prey upon them, but never with success. The wolves crawling through the grass attempt to seize their victims by stealth, for, notwithstanding Mark Twain's very graphic description of the speed of the coyotes, they are hardly a match for the antelopes. The warning snort of a buck quickly brings the herd compactly

together upon some eminence, when the males gathered about watch sharply the movements of their enemy; when closely pressed they take refuge in flight.

There has been much dispute as to whether the male antelope habitually sheds his horns. The weight of evidence is strongly in favor of it; but I should hesitate before positively affirming it myself. At all events the new horns must attain their strength and size *very* soon after the disappearance of the former ones. A female is occasionally shot having a remarkable development of rudimentary horns; in one instance, a doe with kids had horns that measured four inches, with the prongs proportionately developed. Their horns are, however, soft and pliable, with the rudimentary horn-core but little if any developed.

In conclusion, I would call the attention of naturalists to the importance of securing legal protection for this, one of the most interesting of all American mammals, that it may not share the fate that is fast overtaking the buffalo. The antelope can never exist in even a moderately inhabited country. The vast unproductive region of Western Kansas and Eastern Colorado will be its home so long as this region remains comparatively unsettled, provided suitable legislation can be effected in its favor.

ON THE LAWS OF DIGITAL REDUCTION.

BY JOHN A. RYDER.

AT a recent meeting of the Philadelphia Academy I called attention to several facts bearing upon an explanation of digital reduction. It was suggested that the fact of the number of toes being least wherever mechanical strains were greatest and impacts most frequent and most severe might be regarded as an effect of such increased intensity of strains. To make this conclusion appear valid it was only necessary to refer to the foot-structure of the different orders of the class of mammals.

It may be observed that among the primates the only creature having any one toe greatly augmented in size and strength is man; here it is the great one, or the first of anatomists. Its whole structure, especially the articulation with the carpus, calls to mind the condition of things found to exist in the groups which have undergone the most modification in the structure of the feet, namely, the ungulates or hoofed animals, kangaroos, and jumping mice. The calibre of its distal elements is greatly in-

creased, while the ento-cuneiform and navicular are greatly flattened or modified in the same way as the magnum and unciform of the manus and the middle and ecto-cuneiforms of the pes are in many ungulates, or as is the cuboid in the kangaroos.

In ungulates the third and fourth toes become functional, the second and fifth either disappearing or else assuming the office of lateral supports. In the jumping mice (*Dipodidæ*) the second, third, and fourth of the hind feet are the functional ones; in one species three toes are all that remain; in another with four the fifth, a rudimentary one, does not reach the earth; and in another species with five the first and fifth toes are rudimentary. In these three animals, then, of one family and only generically separable by the difference in the number of toes, we have a case in living animals resembling the "demonstrative evidence" of Professor Huxley drawn from fossil horses' toes, which so far as the necessity for time is concerned shows that creatures of almost identically the same habits and structure may be cotemporaneous, yet differing widely in the number and length of the hind toes. It indicates, it seems to us, that toe modification goes on at greatly varying rates. In the kangaroos the fourth and fifth toes of the hind foot are most strongly developed, while the second and third are atrophied and used only to cleanse the fur. It may be noted here, also, that the toes of the fore foot of the kangaroo remain entirely unmodified, and much the same as is the case in the jumping mice, for the reason that the strains are more equally distributed.

The *Chrysochloris* amongst moles offers an instance where the digital reduction has taken place in the anterior extremity, where also the mechanical strains are most frequent and severe. The same fact is observed in *Cyclothurus*, a little South American arboreal ant-eater, where but two functional toes remain upon the fore foot. In the great ant-bear (*Myrmecophaga*), the third digit of the manus is the strongest, the others evidently undergoing reduction, while the former is being constantly augmented by the strains to which it is subjected in obtaining insect prey.

The sloths of both recent and extinct groups furnish an instance where the number of toes has been reduced from the typical number five to as few as two in one pair of extremities in the living *Cholœpus*. The digits also in recent species are of about equal length, which cannot be said of the extinct terrestrial species, where in some cases (*Mylodon* and *Megalonyx*) considera-

ble inequality existed. The equality in existing species is no doubt due to the equality of tractile strains upon each one of the digits, owing to the peculiar method of climbing and hanging to the limbs of trees by the great hook-like claws.

The frequent reduction in the number of toes in the foot before it commences in the hand is seen in the carnivorous groups *Felidæ* (cats) and *Canidæ* (dogs), in odd-toed ungulates, in the swift-foot terrestrial *Rodentia*, and universally amongst such animals as perform locomotion entirely by leaping with the hind feet, as the kangaroos and jumping mice. Upon this point it may be observed that these creatures all more or less decidedly leap, or else pitch the body through space in running, mainly by means of the hind limbs. The effect of this unequal distribution of strains has shown itself in the hypertrophy of certain digits and their consequent specialization at the expense of the atrophy of the others. The direction in which growth force is manifested is here determined, as it is determined in all kinds of work or exercise, by the increased development of parts most exercised, and shows that the claims of a certain surgeon, who is said to have been able to tell the occupations of tradesmen by inspecting the development of the muscles upon the body are not without foundation. Two cases of this kind have fallen under my own observation, one in the person of a carpenter and another in that of a blacksmith.

It may be well to note in this place that man, the only *primate* whose feet serve exclusively for purposes of locomotion, belongs to the foregoing class. The outer toes in man are weaker, shorter, and less developed than in any of the higher apes, and what may eventually be the fate of these outer toes, if, as many do, he keeps on wearing shoes that a savage would not wear for a single hour, combined with the structure now admirably conditioning a gradual reduction, only our descendants will be able to determine a thousand years hence.

The lines of bones through which strains have been directed are in some way determined by the uses which the feet serve in the life of the animal and its ancestral series. This is supported by the fact that where the strains to be overcome are equally distributed amongst all the digits there is rarely any specialization of toes. In aquatic, marine, and arboreal animals the distribution of strains is comparatively equal, and I now call to mind but a very few exceptions to this rule, which is but slightly affected by even these. One case is the *Cyclothurus*, where, however, the hind foot and tail are modified into grasping organs,

leaving the great pair of claws in front for the purpose of tearing up the bark and getting into crevices in searching for insects. The *Dendrolagus* or tree kangaroo is another instance, but here the descent from the terrestrial kangaroos is too obvious to require discussion. In studying the fossil kangaroos Professor Owen noticed that the fur-claws were not as rudimentary as in the living species, showing that at one time there was a more uniform distribution of strains than now.

Among fossorial animals it is usual to find the claws and toes well developed upon the fore limbs; this is so in the moles, armadillos, recent and fossil, and in the *Geomyidæ*, or gophers, where the distribution of strains is very unequal in respect to the fore and hind pairs of limbs. So, too, in the group in which man has been included, where the strains are greatest upon the hind pair, as in animals that run rapidly or are capable of making great leaps, like dogs, cats, rabbits, tapirs, cavies, or guinea pigs.

It seems to us the most convincing proof of the doctrine of descent to find man an instance of the same kind of specialization determined by the manner of the distribution of strains as is so often found among the lower groups, such as the horses, sloths, jumping mice, and even-toed ungulates. We would not put him in respect to foot-structure among the true plantigrades, for unlike them the elements of the digits are not uniformly of the same strength and calibre. He might be somewhat clumsily called an inequidigitate plantigrade.

Now as to the osteological side of the question: in man the bones through which the line of greatest mechanical strain passes are the first digit, ento-cuneiform, navicular, calcaneum, and astragalus. In the horse this line passes through the third digit, external cuneiform, navicular, astragalus, and calcaneum in the hind foot; through the third digit, magnum, scaphoid, and lunar in the fore foot. In the kangaroo through the fifth, but mainly through the fourth digit, the cuboid, calcaneum, and astragalus in the hind foot. It will be noticed also that in the highest member of the highest group it is the first digit that is specialized; in the intermediate groups that the intermediate digits are specialized; that next to the very lowest group it is the fourth digit; and, further, that there are corresponding chains of specialized bones which receive and distribute the strains.[1]

[1] It may be as well to note that birds belong in the category of types which have undergone digital reduction. The ostrich for obvious reasons is the extreme. Among reptiles, turtles and dinosaurs may be included, both of which stand near the birds in the system.

The following summary and conclusions are offered: —

I. That the mechanical force used in locomotion during the struggle for existence has determined the digits which are now performing the pedal function in such groups as have undergone digital reduction.

II. That where the distribution of mechanical strains has been alike upon all the digits of the manus or pes, or both, they have remained in a state of approximate uniformity of development.

III. It is held that these views are Lamarkian and not Darwinian, that is, that they more especially take cognizance of mechanical forces as mutating factors in evolution, in accordance with the doctrine of the correlation of forces.

ON THE DISTRIBUTION OF FRESH-WATER FISHES.

BY DAVID S. JORDAN.

THE writer has been engaged during the two past summers (1876-1877) in collecting fishes in the upper waters of the different river basins in the Southern States, with a view to ascertaining the fish fauna of each and to throw as much light as possible on the laws which govern the distribution of the species. In 1868 and 1869, Professor Cope made very thorough explorations of the upper waters of the Cumberland, Tennessee, Kanawha, James, Roanoke, Neuse, Great Pedee, and Santee. In order to supplement Professor Cope's work, the writer, with his ichthyological assistants, Prof. A. W. Brayton and Mr. C. H. Gilbert, began with the Santee, and proceeded westward across the different river basins, including the Santee, Savannah, Oconee, Ocmulgee, Chattahoochee, Alabama, Tennessee, Cumberland, and Ohio. These rivers, as well as those examined by Professor Cope, have their rise in the Alleghany Mountains, from which they flow in different directions and under the most widely varied physical conditions, thus affording the most favorable opportunity for the study of the effect of these conditions on the distribution of fishes.

Some forty-three species new to science were obtained by us in these Southern rivers, among them several singular and interesting forms, but of these I do not purpose to speak at present. I shall confine myself to the statement of a number of propositions — apparently truths — in regard to the distribution of

fishes, which have been drawn from my own experience as a collector. In these, I have had reference chiefly to the smaller or non-migratory species, the *Centrarchidæ*, *Etheostomatidæ*, and *Cyprinidæ*. The larger species are generally too little known or are too widely distributed to be especially considered here.

The theoretical questions of how fishes have become dispersed, or how and why they have in past time extended their range, I do not propose to discuss. These points and others noticed below have been ably treated by Professor Cope.[1]

It may be premised that some of the propositions contained in the following pages are probably only half truths, to be more completely stated as our knowledge increases.

I. In the case of rivers flowing into the *ocean* the character of the faunæ of the upper waters compared one with another bears no or very little relation with the places of discharge. An illustration of this may be taken in the general similarity of the faunæ of the Youghiogheny and Upper Potomac rivers, — or in the greater resemblance existing between the faunæ of the Chattahoochee and Ocmulgee than between those of the Chattahoochee and Alabama. The Wisconsin River and the Red River of the north have a very similar fauna.

II. River basins having a similar discharge into some larger river or lake have a similarity of fauna due to this fact, and in general, other things being equal, the nearer the points of discharge, if in *fresh water*, the greater the resemblance. The almost identical fauna of the Catawba and Saluda will exemplify this.

III. The higher or the older the water-shed between two rivers, the fewer species are common to both. (This needs further investigation.)

IV. Certain species — not including "species of general distribution" — occur on opposite sides of even the highest water-sheds. This fact was first noticed by Professor Cope. The occurrence of *Luxilus coccogenis* and *Hybopsis rubricroceus* in the Tallulah and Little Tennessee rivers will illustrate. Neither species is known as yet from any river basin other than the Savannah and Tennessee. The existence of *Platygobio gracilis* in the upper waters of the Missouri and Colorado is another illustration.

V. When the water-shed between two streams is a swampy upland instead of a mountain range, the same species will be

[1] Journal Acad. Nat. Sci., Phila., 1868, pp. 239–247.

found in the head waters of both, although the faunæ of the lower courses may be different. In case the one stream flows northward and the other southward, the common fauna will be essentially that of the northernmost stream.

In Northern Indiana, the same species occur in the head waters of the St. Joseph's, Maumee, Wabash, and Illinois rivers, although these streams discharge their waters in widely different directions. This is accounted for in the fact that the swampy waters-shed is often overflowed, affording in the spring an easy water communication.

VI. Many species inhabiting small tributaries of any river are different from those abounding in the river channels. This fact is well known.

Among the brook species may be enumerated *Eucalia inconstans*, *Chrosomus erythrogaster*, *Pœcilichthys spectabilis*, *Xenotis lythrochloris*, *Semotilus corporalis*, *Xenisma stellifera*, *Salmo fontinalis*, the species of *Rhinichthys*, etc., etc. Of the channel species, such as *Hyodon*, *Haploidonotus*, *Dorysoma*, *Pomolobus*, *Roccus*, all the buffalo-fishes and the larger cat-fishes, *Ichthælurus punctatus*, *Pelodichthys olivaris*, *Amiurus nigricans*, and the like will serve as examples.

VII. Many species inhabiting the upper course of a stream are different from those of the lower. This subject has been well discussed by Professor Cope,[1] but further investigations, especially of the rivers of the Southern States, are much to be desired.

VIII. This difference in the upper and lower faunæ is due chiefly to differences in physical conditions of either water, river-bed, food, or climate.

IX. Hence, if in the same river basin there are two streams flowing into the larger stream, the one near the source, the other near its mouth, and these two streams are similar in all known physical respects, their faunæ will be similar, and if dissimilar they will have different faunæ. The general identity of the fishes of Elk River in Western Tennessee and those of Powell's River may be noticed in this connection.

X. Some species of fishes are confined strictly to a single river basin, while others, with apparently no better means of defense or of diffusion, are widely distributed, inhabiting many rivers. In illustration of this the narrow range of each of the colored species referred to *Photogenis* may be compared with the range of *Luxilus cornutus*, which extends from Maine to Arkansas and Montana.

[1] Loco citato.

In the genus *Nocomis* (*Ceratichthys* Baird) *N. biguttatus* probably occurs in every river from Pennsylvania to the Great Salt Lake, while four species of the same genus, *N. micropogon*, *N. monachus*, *N. zanemus*, and *N. labrosus*, are each, so far as is known, confined to a single river basin.

XI. In any river basin the most abundant species (of small fishes) are usually (*a*) those peculiar to it, or some of them; or (*b*) those of the widest distribution. In illustration of this we may notice the abundance of "*Photogenis*" *pyrrhomelas* and *Nototropis photogenis* in the Santee; of "*Photogenis*" *stigmaturus* and *Luxilus cornutus* in the Alabama; of "*Photogenis*" *eurystomus* and *Nocomis biguttatus* in the Chattahoochee; of "*Photogenis*" *xænurus* and *Notemigonus Americanus* in the Ocmulgee. To this rule, however, there are many exceptions and modifications.

XII. In general, the further south any river basin lies, the more species are peculiar to it and the greater the difference between its fauna and that of the neighboring streams. In illustration of this, the differences existing between the faunæ of the Alabama and Chattahoochee may be compared with those between the Susquehanna and the Delaware. Twelve genera are known as common to the Alabama and Chattahoochee, twenty-three to the Susquehanna and Delaware. In the Southern streams, the process of evolution of specific forms seems to have progressed more rapidly.

XIII. Species of the widest distribution often have breaks in their range which cannot be accounted for by any facts now in our possession. *Luxilus cornutus*, — the common shiner or red-fin of New England, — so abundant in all the rivers of the North and West, does not occur, so far as is known, in any of the rivers between the Neuse and the Alabama, in both of which streams it is very numerous. Various other species range over several river basins and then cease abruptly. *Amuirus brunneus* is the most abundant food-fish in the rivers from the Santee to the Chattahoochee, while in the next river westward — the Alabama — it is unknown.

XIV. Many species of wide distribution which are absent in certain streams are there represented by certain other related species which may be regarded as modified descendants. Thus, in the South Atlantic streams, *Chænobryttus gulosus* is represented by *Chænobryttus viridis*, *Notemigonus chrysoleucus* by *Notemigonus Americanus*, etc. In the Southwest, *Eupomotis aureus* is

represented by *Eupomotis pallidus*. In the West, *Noturus gyrinus* by *Noturus sialis*, *Noturus insignis* by *Noturus exilis*, *Umbra pygmæa* by *Umbra limi*.

XV. Other species under similar circumstances have no such "representatives." The case of *Luxilus cornutus* will again illustrate.

XVI. Certain species have been known to extend their geographical range since the opening of the canals. Such are more especially migratory species of probably marine origin, as, for example, *Dorysoma heterura*, *Pomolobus chrysochloris*, and *Anguilla vulgaris*, now abundant in Lake Erie and Lake Michigan, but formerly unknown there. The range of certain *Percidæ* and *Centrarchidæ* has been extended by the same means.

XVII. Rivers flowing parallel into the same larger stream have more in common than rivers having their mouths nearer together but flowing from opposite directions. The Wabash and Miami have more in common than either has with the Kentucky.

XVIII. The characteristically American forms of fishes are, generally speaking, rare or absent in the waters of New England and of the Pacific slope. This fact has been apprehended by Professor Agassiz, who called New England "a zoölogical island."

About one hundred and five genera of fresh-water fishes inhabit the waters of the United States, east of the Mississippi River. Of these, the following seventy-seven do not occur in New England (exclusive of Lake Champlain and tributaries of the St. Lawrence): —

Potamocottus,	Stizostethium,	Typhlichthys,	Gila,
Cottopsis,	Micropterus,	Chologaster,	Nocomis,
Triglopsis,	Ambloplites,	Astyanax,	Ericymba,
Ammocrypta,	Acantharchus,	Percopsis,	Exoglossum,
Pleurolepis,	Chænobryttus,	Thymallus,	Lagochila,
Percina,	Apomotis,	Hyodon,	Placopharynx,
Alvordius,	Xenotis,	Campostoma,	Myxostoma,
Ericosma,	Xystroplites,	Hybognathus,	Cycleptus,
Hadropterus,	Mesogonistius,	Pimephales,	Carpiodes,
Imostoma,	Hemioplites,	Hyborhynchus,	Ichthyobus,
Rheocrypta,	Copelandia,	Hybopsis,	Bubalichthys,
Ulocentra (Jor.	Centrarchus,	Lythrurus,	Ichthælurus,
MSS.),	Pomoxys,	Cyprinella,	Pelodichthys,
Diplesium,	Haploidonotus,	Erogalia (Jor.	Noturus,
Nanostoma,	Aphododerus,	MSS.),	Amia,

Nothonotus,	Eucalia,	Notropis,	Lepidosteus,
Pœcilichthys,	Labidesthes,	Cliola,	Litholepis,
Etheostoma,	Xenisma,	Phenacobius,	Polyodon,
Microperca,	Zygonectes,	Chrosomus,	Scaphirhynchops.
Elassoma,	Amblyopsis,	Phoxinus,	

Of the genera found in New England, only *Salmo*, *Esox*, *Rhinichthys*, and perhaps *Amiurus* are represented by more than one species. From thirty to thirty-five genera occur in the waters of the Pacific slope.

XIX. The larger the river basin, the greater its variety of forms, — both generic and specific. Compare the number of species inhabiting any of the tributaries of the Mississippi with those of any eastern river. Seventy species have been taken in the little White River at Indianapolis, representing forty-eight genera, twice as many as occur in all the rivers of New England.

XX. Other things being equal, a river whose course lies in a region of undisturbed stratified rocks or of glacial drift contains most genera and species.

XXI. Conversely, rivers whose courses lie over igneous or metamorphic rocks contain fewest species. Such rivers often contain great numbers of individuals.

XXII. Sources of streams on opposite sides of a high water-shed often have species in common which do not occur in the lower courses of the same rivers. Some mountain species, as *Salmo fontinalis* and *Hybopsis rubricroceus*, exemplify this.

XXIII. Certain species have a compact geographical range, occurring in all waters within this range, without apparent regard to the direction of their flow. Such are *Lepiopomus obscurus*, in the Alabama, Tennessee, and Cumberland, and *Hybopsis microstomus* in the James, Roanoke, Kentucky, Cumberland, and Clinch.

XXIV. Certain species have a wide east and west range, apparently regardless of the course of the rivers, but are bounded on the north or south by parallels of latitude.

Eucalia inconstans is found from Western New York to Kansas, and northward — but never southward — of a line passing about fifty miles south of Lake Erie. *Percopsis guttatus* has a like range, but its southern boundary is in the Potomac and Ohio. *Lota lacustris* is similarly circumscribed. The three species of *Lythrurus* have each a belt of latitude, — *L. cyanocephalus* belonging to the Great Lakes and Upper Mississippi, *L. diplæ-*

mius to the Ohio and Potomac, *L. ardens* to the Cumberland, Roanoke, and James.

XXV. Certain species have a peculiar northern and eastern range, occurring in the Upper Mississippi, in the head waters of the Illinois, Wabash, and Scioto, thence through the Great Lakes and New England, thence to South Carolina on the eastern slope of the Alleghanies. Such are *Perca Americana*, *Eupomotis aureus*, and *Amiurus catus*.

XXVI. Certain species have a peculiar northern and western range, occurring in the Middle States and in the Great Lakes and usually southward in the east to some point in Virginia or North Carolina, ceasing in the same latitude on both sides of the Alleghanies, but extending southwestward through the Mississippi Valley to the Gulf. Among these may be mentioned *Luxilus cornutus*, *Notemigonus chrysoleucus*, *Ambloplites rupestris*, *Apomotis cyanellus*. The last-named species, however, scarcely extends east of the Alleghanies.

XXVII. Certain species have a wide range north and south, either east or west of the Alleghanies, which do not cross that chain. Of these may be mentioned *Lepiopomus auritus*, *Enneacanthus obesus*, *Aphododerus Sayanus*, *Esox reticulatus*, etc., on the east, and *Haploidonotus grunniens*, *Hyodon tergisus*, *Noturus miurus*, *Noturus sialis*, etc., on the west.

XXVIII. The distribution of fresh-water fishes is dependent on (*a*) fresh-water communication; on (*b*) character of stream, that is, of water, as to purity, depth, rapidity, vegetable growth, etc.; on (*c*) the character of the river bed, as to size, condition, of bottom, etc.; on (*d*) climate, as determined by latitude and by elevation above the sea; and finally on (*e*) various unknown factors arising from the nature or the past history of the species in question, or from the geological history of the rivers.

RECENT LITERATURE.

AMERICAN INSECTIVOROUS MAMMALS. — Dr. Coues has recently published a preliminary paper on the American Insectivora,[1] in which are described three new subgenera and five new species of *Soricidæ*.

[1] *Precursory Notes on American Insectivorous Mammals, with Descriptions of New Species.* By ELLIOTT COUES. Captain and Assistant Surgeon United States Army, Secretary and Naturalist of the Survey. Bulletin U. S. Geology and Geographical Survey, vol. iii. No. 3, pp. 631, 653. Department of the Interior: Washington. May 15, 1877.

The new subgenera are *Soriciscus* (subgenus of *Blarina*), *Microsorex* and *Notiosorex* (subgenus of *Sorex*). Four of the new species belong to the genus *Sorex* and the other to *Blarina*. This paper forms the first general notice of the genera and species of the American moles and shrews that has appeared since the publication of Professor Baird's well-known work on the Mammals of North America, in 1857 — twenty years ago. Much material has in the meantime accumulated, which shows that the number of species then admitted "require to be largely reduced," while others must be added, based on material since collected; but all the generic and subgeneric distinctions pointed out by Professor Baird "are confirmed." In 1861, according to Dr. Coues, Professor Baird again reviewed the subject, "making new and important determinations, which, however, have never been published." Many of these are inedited from Professor Baird's MSS.

In these "Notes," which are "to be considered as preliminary to a monograph of the American Insectivora, now in preparation," Dr. Coues recognizes four genera of moles (*Talpidæ*), namely *Scalops*, *Scapanus*, *Condylura*, and *Urotrichus*; the last common to Western North America and Asia, the others strictly American. These are each represented by a single species, except *Scapanus*, which has two, the one (*S. Breweri*) eastern, the other (*S. Townsendi*) western. The *Scalops argentatus* of Audubon and Bachman (and also of Baird) is considered as merely a geographical race of the common eastern *S. aquaticus*.

Of the shrews (*Soricidæ*), no formal list of species is given, but the genera and subgenera are discussed and characterized in detail, and their distribution is quite fully indicated. The genera and subgenera recognized are as follows: 1. *Neosorex*; 2. *Sorex*, embracing subgenera, (*a*) *Sorex*, (*b*) *Microsorex* (Baird, MSS.) (*c*) *Notiosorex* (Baird, MSS.); 3. *Blarina*, embracing the subgenera (*a*) *Blarina*, (*b*) *Soriciscus* (Coues). The genus *Sorex* alone occurs in the higher latitudes, where it is mainly represented by the subgenera *Sorex* and *Microsorex*, the latter having been recently ascertained to extend to the region of the Yukon River. In the high north the species are few, but the individuals are numerous, being comparable in point of number with the arvicolas and lemmings. *Sorex* proper occurs also throughout the whole of the United States, and is represented farther southward, in Mexico and Central American, by Coues's new subgenus *Notiosorex*. Near the northern boundary of the United States the species of shrews greatly increase in number; where we first meet with the genera *Neosorex* and *Blarina*, the latter being the most characteristic American genus of the family. *Neosorex* occupies a belt across the middle of the continent, from Nova Scotia and New England to Oregon and Washington Territory, and extends southward in the Rocky Mountains to New Mexico. *Blarina* extends far southward, but is represented in Mexico and Central America by only the subgenus *Soriciscus*, and has not yet been met with west of the Rocky Mount-

ains. The shrews are represented by the greatest number of species in the United States; none occur in South America, where also the moles are apparently absent.

The new species described are (1.) *Sorex pacificus* (Baird, MSS. ined.), from Fort Umpqua, Oregon; (2) *Sorex sphagnicola*, from Fort Liard (or vicinity) H. B. T; (3) *Sorex* (*Notiosorex*) *Crawfordi* (Baird, MSS. ined.), from near Fort Bliss, New Mexico; (4) *Sorex* (*Notiosorex*) *evotis*, from Mazatlan, Mexico; (5) *Blarina* (*Soriciscus*) *Mexicana* (Baird, MSS. ined.), from Xalapa, Mexico.

Recent Ornithological Papers. — Among the many faunal lists of birds that have appeared so frequently during the last few years, none exceed in interest Mr. E. W. Nelson's recently published catalogue of the Birds of Northeastern Illinois.[1] The locality, owing to certain topographic l peculiarities, is of a somewhat exceptional character. Its position, midway between the wooded region of the East and the treeless plains of the West, with the Great Lakes in close proximity, and warm river-bottoms extending up from the South, renders it, as Dr. Hoy long since termed the contiguous portions of Wisconsin, a kind of "four corners," where the bird faunas of four regions to some degree interblend. In summer some twenty species, characteristic of more southern latitudes, find here their northern limit of distribution, extending considerably further north here than on the Atlantic coast or in the intervening region. A dozen other species whose proper homes have been considered to be the region west of the Mississippi River or the great plains, still further west, have also been detected as casual visitants. Lake Michigan, with the chain of Great Lakes to the eastward, affords conditions favorable to the development of a decidedly maritime element in the fauna, through the occasional presence in or about its waters of most of the so-called sea-ducks and gulls, as the three species of scoter (*Œdemia*), two species of eider (*Somateria*), the harlequin and the oldwife ducks, and the skua, glaucus, white-winged, black-backed, and kittiwake gulls; and, among shore-birds, such species as the sanderling, the piping plover, and several sandpipers usually regarded as maritime. More unexpected, perhaps, than any of these is the sharp-tailed finch (*Ammodromus caudacutus*), known previously only as an inhabitant of the salt-marshes of the Atlantic coast. In the marshes of Northeastern Illinois, however, it takes on a slightly different phase of coloration, and has become otherwise so far modified as to be recognizable as a distinct race (var. *Nelsoni*), which has been honored with the name of its discoverer.

Mr. Nelson has recorded three hundred and sixteen species, with several additional varieties, as found within the limited area of scarcely more than two counties (Cook and Lake), a considerably larger num-

[1] *Birds of Northeastern Illinois.* By E. W. Nelson. Bulletin of the Essex Institute, vol. viii., pp. 90–155, April, 1877.

ber than has been recorded from any other locality of equal extent in the United States. While this large number shows the thoroughness with which Mr. Nelson has performed his work, this alone but imperfectly indicates the value of his paper, which embraces not only the usual notes respecting the times of migration, nesting, and relative abundance of each species, but here and there important additions to the biographies of hitherto little-known species, including accounts of the songs of several species not before described, and the nests and eggs of others, and their breeding habits. Particularly noteworthy is the discovery of the nest and eggs, in Illinois, of several species previously supposed to nest only in much higher latitudes, one of these being the greater yellow-legs (*Totanus melanoleucus*). Among the curious things recorded is the nesting of the qua-bird or night heron *on the ground* in the Calumet Marshes, the nests being placed in dense clumps of wild rice. The paper is written clearly and concisely, and nowhere contains redundant matter.

Since the publication of Mr. Nelson's above-noticed paper on the Birds of Northeastern Illinois, he has given us further information respecting the birds of Southern Illinois.[1] This paper contains notes on one hundred and thirty-three species, based on observations made at several different localities, embracing the vicinity of Mount Carmel, Fox Prairie in Richland County, Anna in Union County, and the vicinity of Cairo. It contains much information relating to the distribution of the summer birds of the region treated, and here and there interesting biographical notes concerning imperfectly known species.

Respecting a more southern locality we have an important paper by Lieut. C. A. H. McCauley[2] on the ornithology of that portion of Texas near the source of the Red River. This paper, containing notices of about one hundred species, is particularly welcome as throwing much light upon a region hitherto ornithologically little known. Although based on the observations of a few months in summer, it comprises much valuable matter, relating especially to the distribution and habits of the species met with. Here, as generally on the treeless plains of the interior, few species of birds are found except in the vicinity of the timber-skirted streams, where bird-life is generally abundant. The region reported upon embraces a portion of the so-called Staked Plain or Llano Estacado.

We have received also a Catalogue of the Birds of the Vicinity of Cin-

[1] *Notes upon Birds observed in Southern Illinois between July* 17 *and September* 4, 1875. By E. W. NELSON. Bulletin of the Essex Institute, vol. ix., pp. 32–65, June, 1877.

[2] *Notes on the Ornithology of the Region about the Source of the Red River of Texas.* From Observations made during the Exploration conducted by Lieut. E. H. Ruffner, Corps of Engineers, U. S. A. By C. A. H. MCCAULEY, Lieut. Third U. S. Art. Annotated by DR. ELLIOTT COUES, U. S. A. Bulletin of the United States Geological and Geographical Survey, vol. iii., pp. 655–695, May 15, 1877.

cinnati, Ohio,[1] by Mr. Frank W. Langdon. This carefully prepared list numbers two hundred and seventy-nine species, nearly all of which are known to have been taken at the locality indicated. The few included on the basis of their general known range are significantly distinguished as being thus included, and embrace only such species as are quite likely to be met with at the locality in question.

A paper on The Summer Birds of the Adirondacks,[2] by Rooseveldt and Minot, forming a list of ninety-seven species, with short notes respecting their relative abundance, gives us our first formal list of the birds of this interesting region.

Among other recent papers relating to American ornithology may be mentioned a paper by Mr. Robert Ridgway, on The Birds of Guadalupe Island, discussed with reference to the present Genesis of Species.[3] This paper deals especially, as its title indicates, with the origin of the few insular forms which make up the avian fauna of this small island, and discusses the relationship of these forms to the birds of the adjacent main-land. The species thus far well known from this island, situated about two hundred and twenty miles southwest from San Diego, number only eight, and their affinities are almost entirely, as would be expected, with those of Western North America. Yet they are so far differentiated from them that they are recognized by Mr. Ridgway as specifically distinct. They all differ somewhat similarly from their nearest main-land allies in three principal features, namely, in (1) "increased size of the bill and feet, (2) shorter wings and tail, and (3) darker colors." These facts point emphatically to the directly modifying influence of the peculiar conditions of environment to which they are subjected, and, taken with other now well-known facts, lead to the conclusion that the present differentiation of species and subspecies is mainly the result of the immediate action of climatic and other surrounding conditions.

In a paper entitled Corrections of Nomenclature in the Genus Siurus,[4] Dr. Coues, after a few preliminary remarks respecting the general subject of nomenclature, shows clearly the necessity for a change of name in two of our three species of wagtail thrushes, and gives an exhaustive table of synonymy for each species.

NORTH AMERICAN FUR-BEARING ANIMALS. — In the August number of the NATURALIST (Vol. ix., p. 505) was printed a circular, prepared by Dr. Elliott Coues, U. S. A., and issued from the Surgeon-General's office, in relation to a work in preparation, to be entitled History of

[1] *A Catalogue of the Birds of the Vicinity of Cincinnati, with Notes.* By FRANK W. LANGDON. 8vo, pp. 18. Salem, Mass., Naturalist's Agency. 1877.

[2] *The Summer Birds of the Adirondacks in Franklin County, New York.* By THEODORE ROOSEVELDT, JR., and H. D. MINOT. 8vo, pp. 4.

[3] Bulletin of the Nuttall Ornithological Club, vol. xi., pp. 53–58, July, 1877.

[4] Bulletin of the Nuttall Ornithological Club, vol. xi., pp. 29–34, April, 1877.

North American Mammals, to be published by the government. We have before us a "specimen fasciculus" of this work, treating of the family *Mustelidæ* or "fur-bearing animals" of North America.[1]

In point of completeness and thoroughness of elaboration we know of no similar work at all comparable with it. Its scope, so far as the species treated are concerned, is sufficiently indicated by the accompanying transcript of the title-page. In the present short notice it only remains for us to state that while the technicalities of the subject — embracing exhaustive tables of synonymy and bibliographical references, full and discriminating diagnoses of the higher groups as well as of the several species and varieties, the etymology of the various names applied to the genera and species, including the vernacular of various languages as well as the systematic, and the geographical range of each species — are ably handled. There are also added elaborate and detailed biographies of all the American species treated, with shorter and more technical notices of all of their more closely related affines of other parts of the world. Incidentally are given many interesting statistics of the fur-trade, while what we may term the literary history of each species comes in for a large share of attention, and forms by no means one of the least attractive features of the work. The author has drawn from all trustworthy sources of information and has woven into his chapters, with his well-known skill and gracefulness of style, all that is essential to the subject, — all, we might say, that is worth knowing of the animals treated. With this is blended no small amount of information derived by the author from personal observation in the field, with much other matter hitherto either unpublished or concealed in little-known publications. Such special characteristics of the family as the anal glands, which in one group serve so powerfully as an organ of defense, are treated in detail, while the terrible disease known as *rabies mephitica* or hydrophobia from skunk bite receives the full treatment its importance and peculiar interest demand, a dozen pages being devoted to the history of this fruitful source of rabies among dogs and other domestic animals. As a monograph covering the whole field of the popular and technical phases of the subject, it is simply a model of literary workmanship. As nothing of a general character has appeared in the way of a popular history of the mammals of North America for thirty years, or since the publication

[1] *Fur-Bearing Animals.* A Monograph of North American Mustelidæ, in which an account of the Wolverene, the Martens or Sables, the Ermine, the Mink, and various other kinds of Weasels, several species of Skunks, the Badger, the Land and Sea Otters, and numerous exotic allies of these animals, is contributed to the History of North American Mammals. By Elliott Coues, Captain and Assistant Surgeon United States Army, Secretary and Naturalist of the Survey. Illustrated with sixty figures on twenty plates. Department of the Interior, United States Geological Survey of the Territories, F. V. Hayden, United States Geologist. Miscellaneous Publications, No. 8. 8vo. pp. xiv., 348. Washington: Government Printing Office. 1877.

of Audubon and Bachman's great work, — an admirable one for the time but long since rendered antiquated and sadly incomplete through later increase of knowledge, — it is most fortunate that the task of preparing a new history of the subject from the abundant materials now at command has been undertaken by one so thoroughly competent for the task. In the way of unfavorable criticism we have only to add that the plates illustrating the skulls and dentition of the species described are unworthy of the accompanying text. They are referred to as an attempt at delineation by a new process, from which with further experience probably better results may be expected. While the figures are highly useful and fairly expressive, they are artistically harsh and unpleasing. We have as yet evidently no short cut to excellence in the graver's art.

In respect to typography little more could be desired: the type is large and the page open and clear, while careful revision on the part of proof-reader and author is everywhere apparent.

Books and Pamphlets Received. — Ninth Annual Report of the United States Geological and Geographical Survey of the Territories, embracing Colorado and Parts of Adjacent Territories; being a Report of Progress of the Exploration for Year 1875. By F. V. Hayden, United States Geologist. Conducted under the authority of the Secretary of the Interior. Washington: Government Printing Office. 1877. 8vo, pp. 827; 70 plates, 7 maps, and 67 wood-cuts.

Ethnography and Philology of the Hidatsa Indians. By Washington Matthews Assistant Surgeon United States Army. Department of the Interior, United State, Geological and Geographical Survey, F. V. Hayden, United States Geologist in Charge. Miscellaneous Publications, No. 7. Washington: Government Printing Office. 1877. 8vo, pp. vi., 239.

Brehm's Thierleben. Band ii. Heft 5–7. Leipzig. 1877. New York: B. Westermann & Co. 8vo. 40 cents a Heft.

On the Brain of Chimera Monstrosa. By Burt G. Wilder, 1877. 8vo, pp. 32, with a plate. (From the Proceedings of the Academy of Natural Sciences.)

Pacific Coast Lepidoptera. No. 17. On the Transformations of Colias (Meganostoma Reak) Eurydice, Bdv. By Henry Edwards. 8vo, pp. 2. (From the Proceedings of the California Academy of Sciences, 1876.)

Pacific Coast Lepidoptera. No. 18. Description of a N w Species of Heterocampa (Larva and Imago). By Henry Edwards. 8vo, pp. 2. (From the Proceedings of the California Academy of Sciences, October, 1876.)

Pacific Coast Lepidoptera. No. 19. Notes on a Singular Variety of the Larva of Halesedota Agassizii Packd. By Henry Edwards. 8vo, pp. 3. (From the Proceedings of the California Academy of Natural Sciences, November, 1876.)

Pacific Coast Lepidoptera. No. 20. Notes on the Case-Bearing Moths (Psychidæ), with Notices of Californian Species. By Henry Edwards. 8vo, pp. 4, with a plate. (From the Proceedings of the California Academy of Sciences, November, 1876.)

Pacific Coast Lepidoptera. No. 21. Descriptions of Two New Species of the Genus Theda. By Henry Edwards. 8vo, pp. 2. (From the Proceedings of the California Academy of Sciences, December, 1876.)

Pacific Coast Lepidoptera. No. 22. Notes on some Diurnal Lepidoptera, with Descriptions of New Varieties. By Henry Edwards. 8vo, pp. 11. (From the Proceedings of the California Acad my of Sciences, December, 1876.)

Pacific Coast Lepidoptera. No. 23. Description of a New Species of Catocala,

and a List of the California Specimens of the Genus known to occur in Collections. By Henry Edwards. 8vo, pp. 2. (From the Proceedings of the California Academy of Sciences, January, 1877.)

A Partial Synopsis of the Fishes of Upper Georgia, with Supplementary Papers on Fishes of Tennessee, Kentucky, and Indiana. By D. S. Jordan. 8vo, pp. 70. (From the Annals of the New York Lyceum of Natural History, vol. xi.)

Fur-Bearing Animals. By Elliott Coues. 8vo, pp. 348, with 20 plates. U. S. Geological Survey of the Territories, F. V. Hayden, Geologist in Charge, Washington, 1877.

Bulletin of the U. S. National Museum. No. 7. Contributions to the Natural History of the Hawaiian and Fanning Islands and Lower California. By T. H. Streets, M. D., Washington, 1877. 8vo, pp. 166.

Bulletin of the U. S. National Museum. No. 8. Index to the Names which have been applied to the Subdivisions of the Class Brachiopoda. By W. H. Dall. 8vo, pp. 82. Washington, 1877.

Bulletin of the U. S. National Museum. No. 9. Contributions to North American Ichthyology, No. 1. By D. S. Jordan. 8vo, pp. 49. Washington, 1877.

Bulletin of the U. S. Geological and Geographical Survey of the Territories. Vol. iii. No. 4. F. V. Hayden, Geologist in Charge. Washington, 1877. 8vo, pp. 116.

North American Ethnology. Vol. i. By W. H. Dall and G. Gibbs. Large 8vo, pp. 355, with maps and illustrations. U. S. Geological and Geographical Survey of the Rocky Mountain Region. J. W. Powell, Geologist in Charge. Washington, 1877.

Jahres-Bericht des Naturhistorischen Vereins von Wisconsin für das Jahr 1876–1877. Milwaukee, 1877. 8vo, pp. 16,

GENERAL NOTES.

BOTANY.[1]

Gentiana Amarella L. var. acuta (G. acuta Mx.). — While botanizing with Mr. Pringle in Smuggler's Notch, August 9th, we found a small alpine form of this gentian growing abundantly on the sides of one of the steep water-courses that decend from Mt. Mansfield. It is an interesting addition to the flora of New England, and is further indication of the richness of the Notch in boreal plants, to which attention was drawn by Mr. Pringle last year. — C. E. Faxon.

Notes on Some Injurious Fungi, by Professor W. G. Farlow (in Bulletin of the Bussey Institution). — This article is principally devoted to an account of the mold (*Uncinula spiralis* B. and C.) which is common throughout the greater part of the United States. The ripe perithecia have been found from New England to California. The mycelium forms white patches on the leaves and grapes. The conidia which have been known for some time have generally passed for the mold common on European vines (*Oidium Tuckeri*), but it is very doubtful, in spite of their resemblance to one another, whether they are the same thing. The *Uncinula* is more injurious to the grapes than *Peronospora viticola*, as it attacks the berries as well as the leaves. The article contains a few remarks on the vegetable origin of certain

[1] Conducted by Prof. G. L. Goodale.

common knots found on trees. In this connection it is mentioned that the black knot (*Sphæria morbosa*) has been found on the beach plum at Martha's Vineyard.

THE NEW BUILDING FOR THE KEW HERBARIUM. — In the August number of the *Journal of Botany* is a part of Sir J. D. Hooker's Report for the Year 1876 of the Herbarium of the Royal Gardens at Kew: "The new building for the accommodation of the herbarium is in a very advanced state. It will consist of a hall attached to the back of the present house. The whole of the latter will be preserved except the drawing-room, a single apartment that was added on to its north side, and which has been removed to make room for the new hall, which is eighty-six feet long by forty feet broad, and contains two galleries ten feet broad running round it. The galleries will communicate with each other and with the ground-floor by two circular iron staircases placed one at each end of the building. On each floor there will be an entrance from the old building closed by double iron fire-proof doors. The long sides of the building will be lighted with forty-eight windows, eight on each floor on each side. The cabinets for holding the specimens will be arranged in blocks eight feet high, of two tiers projecting like buttresses between the windows on the ground-floor and galleries, thus accommodating the greatest number of cabinets with the least loss of space, a very important consideration, considering the extent of the collection and the time that would be otherwise lost in consulting it. At the present time the number of cabinets is upwards of six hundred, and the estimated number of specimens contained in the whole is now considerably over a million, reckoning as one all the individuals of the same plant from the same locality."

BOTANICAL PAPERS IN RECENT PERIODICALS. — *Trimen's Journal of Botany*, July, 1877. J. L. Warren, Notes on Some Sussex Plants. E. M. Holmes, The Cryptogamic Flora of Kent (continued in August number). H. F. Hance, On *Sportella*, a New Genus of Rosaceæ (from China). Various short notes and interesting abstracts. August, H. Polakowsky, Catalogue of Costa Rica Plants. R. A. Pryor, On Bobart's Green *Scrophularia* (now identified as a monstrosity of *S. nodosa*). The same writer communicates also a short note on *Carum bulbocastanum*, a list of interesting plants in North Buckinghamshire, England, and an account of *Buxus sempervirens* in the same district. Among the abstracts we find the Report of the Kew Herbarium for 1876 (elsewhere noticed).

Annales des Sciences Naturelles, Botanique, July, 1877. Sorokine, Notes respecting the Vegetable Parasites of *Auguillulæ*. Also, by the same author, Notes in Regard to *Ascomyces polysporus*. Naudin and Radlkofer, The Influence which Changes of Climate have on Plants. Vesque, On the Absorption of Water by Roots, in its Relations to Transpiration.

Flora, No. 19. Professor Julius Klein, Notes on Algæ, continued. No. 21. Arnold, The Mosses of the Jura. Dr. Prantl, On *Hysterium Pinastri* Schr. as a Cause of Leaf Disease in the Pine. No. 22. Dr. A. Minks, The Lichen Question.

Botanische Zeitung, No. 30. De Borbás, Concerning some Iridaceæ, especially those of Hungary. Warnstorf, Two New European Musci. Reports of Societies. No. 31. Dr. Harz, On the Origin and Properties of Spergulin (a new fluorescent from the seed-coats of *Spergula vulgaris*).

ZOÖLOGY.[1]

DEVELOPMENT OF UNFERTILIZED EGGS OF VERTEBRATES AND MOLLUSCA.—In the August number of the NATURALIST I notice a letter from Mr. E. Lewis Sturtevant on the development of unfertilized eggs in the body of the female pickerel, and as the subject is one of great interest, I subjoin a few extracts from my notes, which relate to similar observations.

Dr. Burnett says (Proc. Amer. Acad. of Arts and Sciences, iii., 1847, page 44), "In the ova of the common cod-fish (*Gadus morrhua*) before they are expelled from the ovaries, and therefore before impregnation, I have seen phenomena indicating that the segmentation of the vitellus had already commenced." Professor Agassiz says (Proc. Boston Soc. Nat. Hist., vi., 1856, page 9) that eggs in various early stages of development may be found in the ovaries of the cod, whiting, and hake; but he opposes Burnett's view that this is to be regarded as proof of partheno-genesis, and holds that it rather proves copulation and internal impregnation. According to Bischoff (Mém. sur la Maturation et la Chute periodique de l'Œuf de l'Homme et des Mammifères, indépendant de la Fécondation, Ann. d. Sc. Nat., iii., ser. zool. ii., page 135, 1844) a few of the eggs laid by a female frog which had been kept in solitary confinement are found to go through the early stages of development.

In the *Monthly Microscopical Journal* for July, 1876 (page 44), there is a notice of similar observations upon the frog, which were communicated to the Académie des Sciences. According to this observer the first stages of segmentation were found in some of the eggs dropped by a female frog which had been kept in confinement for about four months, and secluded from all possible intercourse with the male. Segmentation was more rapid and irregular than in fertilized eggs at the same temperature. Only a small number of eggs commenced development; the majority died at once, and the rest very soon and before the mulberry stage was reached. The same phenomenon has also been seen by Leuchart.

Oebacher finds that the eggs laid by virgin hens, which have been reared in confinement, undergo segmentation and form a blastoderm

[1] The departments of Ornithology and Mammalogy are conducted by Dr. ELLIOTT COUES, U. S. A.

while in the oviduct. In the case of the hen this does not seem to be exceptional but normal, as it appears to occur in nearly every case; and Oebacher concludes from his observations upon the subject (Die Veränderungen des unbefruchteten Keimes des Hühnereier im eileiter und bei Bebrütungsversuchen, Zeitschr. f. Wiss. zool., xxii., 1872, page 220): "We may therefore state confidently that the hen's egg goes through the process of segmentation during the intrametral period, whether it is fecundated or not, and we must therefore regard it as brought about by the organization of the egg itself, and not as caused by the influence of the male fluid."

Bischoff has found eggs in various stages of segmentation in the ovaries of a virgin sow which had been carefully separated from the male during life, and Hensen has made similar observations upon the rabbit. According to Vogt (Bilder aus dem Thierleben, page 217) the unfertilized eggs of *Firola* undergo segmentation; and Quatrefages records the same thing in *Unio* (*Compt. Rend.*, 1849, page 101). In the *Niades* the eggs are certainly discharged from the ovaries before impregnation takes place, although it is of course possible that some of the spermatic fluid may gain access to the oviduct. As the cilia of this duct are so placed as to cause an outward current this is hardly probable, and I have found and figured segmented eggs in the follicles of the ovary of *Anodonta*. These eggs were taken from the ovary a few days after the brood for that year had passed into the gills; and they were fully grown and ripe, and were very plainly the remnants of the brood of that season, which from some cause had failed to escape into the oviduct and pass into the gills. They did not differ in any particular from fertilized eggs at the same stage of development.

These cases are by no means all which might be collected to show that in groups of animals in which partheno-genesis does not occur, the eggs have still the power to go through part of the process of development without fertilization, and I believe, from conversations with fishermen and fish-breeders, that among fishes this is by no means rare. As partheno-genesis is normal among many of the lower animals, and since traces of the same power are thus found among the higher vertebrates, I think that we must conclude that the egg has in itself the power to form a new individual, although this power is never perfectly, and usually not at all, shown until development is excited by the influence of the spermatic filaments of the male.—W. K. Brooks.

A Black Rattlesnake.—While exploring the cañon of Alameda Creek, about one mile and a half beyond Niles Station, California, one of the civil engineers of the Central Pacific Railroad Company, on the 30th of July, came across a rattlesnake as black as jet, without even a white shade on the belly. The snake had ten rattles, and was three feet in length. Rattlesnakes are not uncommon in this part of the State, and are sometimes killed in Strawberry Cañon, near the university at Berkeley.—R. E. C. S.

NORTHERN RANGE OF THE BISON. — Mr. E. W. Nelson, the well-known ornithologist, now in charge of one of the government meteorological stations in Alaska, writes me as follows under date of St. Michael's, Alaska, July 11, 1877: "I have met here two gentlemen who crossed the mountains from British Columbia and came to Fort Yukon through British America, from whom I have derived some information about the buffalo (*Bison Americanus*) which will be of interest to you. These gentlemen descended the Peace River, and on about the one hundred and eighteenth degree of longitude made a portage to Hay River, directly north. On this portage they saw thousands of buffalo skulls, and old trails, in some instances two or three feet deep, leading east and west. They wintered on Hay River, near its entrance into Great Slave Lake, and here found the buffalo still common, occupying a restricted territory along the southern border of the lake. This was in 1871. They made inquiry concerning the large number of skulls seen by them on the portage, and learned that about fifty years before snow fell to the estimated depth of fourteen feet, and so enveloped the animals that they perished by thousands. It is asserted that these buffaloes are larger than those of the plains." This is confirmatory of the statements I have elsewhere given of the comparatively recent presence of the bison near Great Slave Lake and on Peace and Hay rivers. — J. A. ALLEN.

ANTHROPOLOGY.

ANTHROPOLOGICAL NEWS. — Two very important contributions to American ethnology have just been issued from Major Powell's office. One is entitled Introduction to the Study of Indian Languages, with Words, Phrases, and Sentences to be collected, by J. W. Powell. The paper is to be one of the chapters of a Manual of North American Ethnography, which Major Powell will shortly publish with the aid of eminent specialists. The other work is volume i. of Contributions to North American Ethnology, issued by the Interior Department. Part I. of this volume contains On the Distribution and Nomenclature of the Native Tribes of Alaska and the Adjacent Territory, by W. H. Dall. On a Succession of Shell-Heaps on the Aleutian Islands, by the same. Remarks on the Origin of the Innuit, by the same. Appendix to Part I. contains Notes on the Natives of Alaska, by J. Furnhelm. Terms of Relationship used by the Innuit, by W. H. Dall. Comparative Vocabularies, by George Gibbs and W. H. Dall. Part II. embraces a paper on the Tribes of Western Washington Territory and Northwestern Oregon, with Maps, by G. Gibbs. The appendix to Part II. contains Comparative Vocabularies, by Messrs. Gibbs, Tolmie, and Mengarini; Niskwalli-English Dictionary and English-Niskwalli Dictionary, by G. Gibbs.

The Davenport Academy of Natural Sciences has issued Part I. of

volume ii. of their proceedings, a handsome brochure of 148 pages. The academy, which has grown to be one of the most efficient local societies in the country, contemplates erecting a building for its meetings and for the exhibition of its specimens. The following is a list of the papers on archæology: Exploration of a Mound near Utah Lake, by Julia J. Wirt; Manufacture of Pottery by Mojave Indian Women, by Dr. E. Palmer; Shell Money and other Primitive Currencies, by W. H. Pratt; Mound Explorations in Jackson County, Iowa, by C. T. Lindley; Exploration of Mound No. 3, Cook's Farm Group, and Discovery of Inscribed Tablets, by Rev. J. Gass; On the Inscribed Tablets found by Rev. J. Gass, by R. J. Farquharson; Recent Find of Skulls and Skeletons in Ohio, by Rev. S. D. Peet; Exploration of Mound No. 10, Cook's Farm Group, by Rev. J. Gass; Description of Inscribed Stones found in Cleona Township, Scott County, Iowa, by Rev. J. Gass; Exploration of Mounds on the Farm of Col. William Allen, by W. H. Pratt.

From the author, C. C. Abbott, M. D., we have received a pamphlet reprinted from the Tenth Annual Report of the Peabody Museum, entitled Discovery of Supposed Palæolithic Implements from the Glacial Drift in the Valley of the Delaware River, near Trenton, N. J. As the result of his investigations the author comes to the conclusion that "the rude implements found in the gravel were fashioned by man during the glacial period, and were deposited with the associated gravels as we now find them."

Mr. W. H. Jackson, of the Hayden Survey, has added another trophy to those that decorate his cliff dwelling in the fourth story of the Second National Bank Building, Washington. Having gone out to New Mexico in the spring he made accurate measurements of one of the best preserved of the pueblos, and has now reproduced it in plaster in exact proportions. These plaster models by Mr. Jackson are certainly the best object-lessons in American archæology we have ever seen.

The State Archæological Association of Indiana held its meeting September 12th and 13th, at Indianapolis. The American Anthropological Association met at Cincinnati, September 5th, and the Anthropological Subsection of the American Association at Nashville, Tenn., August 29th.

Nature for May 24th and the following five or six numbers contain a valuable report of a conference held by the London Anthropological Institute, concerning our present knowledge of the antiquity of man in England. Messrs. John Evans, Dawkins, Hughes, Teddemann, Busk, Rolleston, Fox, Sayce, Callard, and Harrison took part in the discussion. The result of the conference seems to have been that as yet no positive evidence has been adduced of the preglacial or intraglacial existence of man in England. Messrs. Belt, Geikie, and Sketchly, in subsequent communications to *Nature*, take issue with this opinion.

In Part IV. of the last volume of the *Journal of the Anthropological Institute* the following subjects of general interest are discussed: The Measurement of the Officers and Men of the Second Royal Survey Militia, by Col. Lane Fox; The Chalk at Cissbury, by J. Park Harrison; The Ethnology of the Germans, by H. H. Howorth; On the Classification of Arrowheads, by W. J. Knowles; On Language and Thought, by Henry Sweet.

Prof. Wills de Hass has issued a Syllabus of a Course of Lectures on American Prehistoric Archæology before the College of Fine Arts, Syracuse University. This being the first attempt to popularize in this manner the whole subject of prehistoric archæology in our country, we would congratulate his hearers if the richness of the lectures bear any comparison with the luscious bill of fare.

We would call the attention of our readers to two works of extraordinary merit, from the pen of our countrymen, and regret that want of space forbids an extended review of them. The one is Peru; Incidents of Travel and Exploration in the Lands of the Incas, by E. George Squier; and the other, Ancient Society: or, Researches in the Lines of Human Progress from Savagery, through Barbarism, to Civilization, by Lewis H. Morgan. Both are the mature if not the final work of our most distinguished anthropologists, — authors whose works are known and whose praises are spoken wherever men are found who look with tenderness upon those mementoes of antiquity which in their day were the stepping-stones of history.

Many archæologists have been astonished at the beauty of form and the exquisite finish of the jadeite celts found in the West Indies, and have often wondered how they were hafted and put to use. The problem has been solved recently by two celts sent to the National Museum from Turk's and Caicos islands, by Mr. George Gibbs. One of them is a light jadeite, oval-sectioned celt set in a mortised handle of hard wood; in the other, the handle and blade are of a single piece of jadeite, sculptured to imitate a celt in a wooden handle. They will be figured in the forthcoming Annual Report of the Smithsonian Institution. From the same locality two low wooden stools were sent by Professor Gabb and Mr. Frith, answering exactly to those described by Herrera and the other historians of the voyage of Columbus. They are made of a single piece of wood, in imitation of a turtle, the head and fore legs projecting in front, and the tail rising to form the back of the stool. These, too, are valuable in establishing the use of certain sagged stone implements hitherto called metates. One of these stone seats in the National Museum, belonging to the Latimer collection, is a fac-simile of the wooden stools above described. These will also be figured in the Smithsonian report for the present year.

A very valuable contribution to American ethnology is Ethnography and Philology of the Hidatsa Indians, by Washington Matthews, assist-

ant surgeon U. S. A., published as No. 7 of Professor Hayden's Miscellaneous Publications. The work forms an octavo volume of 240 pages, and contains, in addition to the grammar and dictionary proper, a very valuable monograph of the Hidatsa, and of their neighbors at Fort Berthold, the Aricarees and Mandans.

Dr. Dalrymple, of Baltimore, has made an exhaustive study of the Pamunkey and Mattapony Indians of Eastern Virginia. They are a miserable half-breed remnant of the once powerful Virginia tribes. The most interesting feature of their present condition is their preservation of their ancient modes of making pottery. It will be news to some that the shells are calcined before mixing with the clay, and that at least one third of the compound is triturated shells.

The discussion of the subject of reform spelling still continues in *The Academy* of June 2d, 9th, and 16th. The chief value of this discussion to the American ethnologist is the aid which a perfect phonetic alphabet would render to those who are engaged in collecting vocabularies or in perfecting the synonymy of the tribes. — OTIS T. MASON.

GEOLOGY AND PALÆONTOLOGY.

ON THE EXISTENCE OF THE ALLEGHANY DIVISION OF THE APPALACHIAN RANGE WITHIN THE HUDSON VALLEY. — In preparing for the last summer campaign of the Harvard Summer School of Geology, my assistant, Mr. William M. Davis, Jr., made a preliminary study of the district lying between the Hudson River and the foot of the Catskill Mountains. From his observations it became evident to both of us that there were peculiar disturbances affecting this district which had remained unnoticed by the officers of the New York surveys. Last month I visited this region along with the Summer School of Geology. A few days' study made it plain to me that Mr. Davis's observations had given us a clew to an important fact in American geology, and that these dislocations, consisting of several abruptly folded anticlinals and synclinals originally having several hundred feet relief, are in fact the northward extension of the disturbances that made the Alleghany division of the Appalachian chain; while the Catskill Mountains similarly are the northward extension of the slightly disturbed table-land known as the Cumberland table-land in the valley of that stream, and by various names in the more northern localities. It will not be possible to give full details of this interesting series of disturbances until the sections and maps made by the summer school are fully worked up, which cannot be for some months to come. It may be said, however, that this structure has been traced about thirty miles along the Hudson River, and that the several anticlinals closely resemble those of Pennsylvania in all their general features: they are, however, smaller, more closely packed together, with much steeper dips, often running up to 50° of declivity, and are somewhat more faulted, but in the direction of their steeper dips their rela-

tions to each other, as well as in all the topographical effects they exercise on the surface, they exactly reproduce the Pennsylvania mountains. I now have no question that the Alleghany disturbances are crowded into the valley of the Hudson, where, worn down by glacial, fluviatile, and at times perhaps marine agencies, and masked by glacial drift, they have hitherto escaped the attention of geologists, and that we must abandon the idea that the disturbances of that age run out beneath the Catskill table-lands.

That it may be seen that these anticlinals are no petty accidents, I may say that the largest yet traced is not less than twenty miles long, a mile or more in width, and if restored would be nearly two thousand feet high. The beds involved in the disturbance include the greater part of the New York Palæozoic section. — N. S. Shaler.

On the Occurrence of the Genus Beatricea in Kentucky. — The genus *Beatricea* described by Billings as a group of fossil corals, and at one time regarded by Hyatt as belonging to the Cephalopods,[1] has hitherto been found only upon the island of Anticosti, in the Gulf of St. Lawrence. The investigations of the Kentucky Geological Survey have now traced this genus into the limits of that commonwealth. There, as in Anticosti, it is the companion of reef-building forms of corals growing in the shelter of very large masses of *Columnaria* and *Tetradium*, and occupying the horizon of the uppermost part of the Cincinnati group. In the new locality the genus is represented by two distinct forms, comparable with the *B. nodulosa* and *B. undulata* of Billings, though perhaps not strictly identical with them. Specimens of these Kentucky forms were exhibited at Nashville. Professor Whitfield, there called attention to the fact that the microscopic structure of this puzzling fossil closely resembled that found in the *Stromatopora* group. On further examination of these forms I am inclined to accept the conclusions to which we are led by this acute observation of Professor Whitfield and to regard these fossils as probably belonging to the group of sponges. Those who are familiar with the Palæozoic sponges will recognize certain approaches to the general form of *Beatricea* among the unquestionable sponges of that time. Certainly the affinities as far as traced are much more reconcilable with those of the group of sponges than with those of the corals. I think this is a more profitable field of inquiry than any other that has suggested itself to me concerning these curious remains. For some years I have been doubting whether they had not some genetic relations with the *Hippurite* group of the *Rudistes*. I should not mention this conjecture, though there is a good deal that appears to support it, were it not that Prof. James Hall tells me he has been inclined to take the same view of their relations. There can be no doubt, however, that the field opened by Professor Whitfield's observations is much more promising. — N. S. Shaler.

[1] I am authorized by Professor Hyatt to say that he is now satisfied that they cannot be regarded as Cephalopods.

THE LARGEST KNOWN SAURIAN. — Professor Cope recently described a new genus and species of saurian with ambulatory limbs under the name of *Camæosaurus supremus*, which exceeds in dimensions any known land animal. The skeleton was found by Mr. O. W. Lucas near Canyon City, Colorado, and a great part of it was preserved in good condition through the labors of that gentleman. Its dorsal vertebræ are occupied by large chambers, a structure in which it differs from *Cetiosaurus*, a genus which it otherwise resembles. Its neck vertebræ are of remarkable form, and the neural arches of the dorsal vertebræ greatly elevated. One of the dorsal vertebræ has an expanse of three and one half feet; another is two and a half feet in elevation. The femur measures over six feet in length, and the tail was very long. If the cervical series included six vertebræ of the proportions of the one preserved the neck was ten feet in length. Another species allied to this one was recently sent to the Yale College museum from a point about one hundred miles north of Canyon City, but it appears to be a smaller animal, and the bones are in an inferior state of preservation.

REMAINS OF A HUGE SAURIAN IN PENNSYLVANIA. — At the recent meeting of the American Philosophical Society, Professor Cope called the attention of the members to a number of teeth of a huge land saurian which evidently inhabited Pennsylvania at an early geological period. The specimens were found by Charles M. Wheatley, of Phœnixville, Pa., in one of the copper mines, in the red sandstone and shale which traverses the State from northeast to southwest, in the eastern section. This reptile, which is new to science, was probably thirty feet in length, with a bulky body, supported by heavy limbs. The teeth are double-edged and finely serrate, and of the kind characteristic of the carnivorous saurians. The reptile was doubtless one of the most formidable that ever inhabited the State, and in point of time the earliest. It has received the name of *Palæoctonus Appalachianus.*

NEW VERTEBRATE FOSSILS. — Prof. O. C. Marsh, in the *American Journal of Science* for September, describes several new species of mammals, birds, reptiles, and fishes from different localities in the West. "Among the mammals are two Miocene Edentates, the first detected in this country, and a third species of this group from the Lower Pliocene. Another mammal of much interest is a rhinoceros from the Eocene, the oldest known member of the family. A number of new genera are introduced, some of which have an important bearing on the genealogy of Tertiary mammals. Among the other vertebrates is a new genus of Crocodilians from the horizon of the Wealden, and a new species of *Crocodilus* from the Pliocene." A new tapiroid animal, intermediate in structure between the extinct *Lophiodon* and the existing tapir, is described from remains from the Miocene of New Jersey (formerly referred to *Lophiodon*) and the Lower Pliocene east of the Rocky Mountains. Two species of *Bison* (*B. ferox* and *B. Alleni*) from the Lower Pliocene

of Kansas and Nebraska are based on fragments of horn cores. These indicate animals much larger than the existing species, but smaller than the large extinct *Bison latifrons*. Another interesting type of mammal combines some of the features of the ungulates with others of the rodents, to which latter it is evidently related. The species (*Allomys nitens*) is founded on remains from the Upper Miocene of Oregon, and is regarded as representing a distinct family, *Allomyidæ*. A new bird of the size of a small duck is characterized from remains from the Cretaceous of Texas.

GEOGRAPHY AND EXPLORATION.

EXPLORATION IN PATAGONIA. — Don F. P. Moreno has recently made an exploration from Santa Cruz Bay, by way of the Santa Cruz River, northward across the high interior of Patagonia, the so-called "Plains of Mystery" of Admiral Fitz Roy, to the base of the Cordilleras. He explored the lake, which had never before been sailed upon, forming the source of the Santa Cruz, and crossed the tertiary tablelands to the northward. These plains have an altitude of two thousand five hundred to three thousand feet, with summits capped with basalt. To the westward and northward he met with a chain of small lakes inclosed by excellent pasture, and later reached an unknown lake of considerable dimensions, named by him Lago San Martin. The lake is surrounded with snow-capped mountains, which are wooded on the sides and rise to a height of three thousand to five thousand feet. He also visited the so-called Viedma Lake, and made collections of fossils from the plains. On a portion of the shores of the lake from which the Santa Cruz takes its rise was discovered an ancient habitation of some of the primitive people of Patagonia. A detailed report of his expedition is promised.

HEIGHTS IN THE BOLIVIAN ANDES. — According to the *Geographical Magazine*, Mr. Minchin, the civil engineer who has been doing such useful geographical work in Bolivia, has determined, from the results of his leveling for the railways between La Paz and Lake Titicaca, the height of the peak of Illimani to be 22,224 feet, which he thinks cannot vary more than ten feet from its true height. It is hence about 175 feet lower than the elevation given by the most trustworthy measurements for the peak of Aconcagua in Chili, believed to be the highest point of the Andes. Mr. Minchin gives the height of Lake Titicaca as 12,545 feet, or 245 feet less than Pentland's height, based on barometric measurement. The height of Alto de la Paz is given as 13,389 feet, and that of Plaza Mayor, La Paz, as 11,946 feet.

GEOGRAPHICAL NEWS. — Mr. F. A. Edwards has published, in the *Gentleman's Magazine* for August, a paper on Colonel Gordon's Expedition to the Upper Nile Region, illustrated by a sketch map. The *Geographical Magazine* for August contains a sketch map of the coun-

try round Lake N'yassa. In the same number is an extended notice, by Keith Johnston, of the cartographical publications of the Indian Survey. These include, besides numerous maps of special districts, the "long-expected" General Map of India. A book relating to the discoveries of the fifteenth century has been published by Richard Henry Major, entitled The Discoveries of Prince Henry the Navigator, and their Results; being the Narrative of the Discovery by Sea, within One Century, of More than Half the World. This period includes the exploration of the coasts of Africa, the discovery of America and Australia, the circumnavigation of the globe, and the opening of a sea-way to India, the Moluccas, and China. J. W. Boddam Whetham, in a book entitled Across Central America, gives interesting notes of travel through a hitherto rarely visited region, with an account of some of the wonderful ruins of Central America.

MICROSCOPY.[1]

E. GUNDLACH'S NEW PERISCOPIC EYE-PIECE. — The Hughenian eye-piece, as originally constructed, consists, as is well known, of two plano-convex lenses, of which one, the field-lens, has three times the focal length of the other, the eye-lens, the distance between the two being equal to double the focal length of the eye-lens, the plane side of the field-lens facing the convex side of the eye-lens.

The field-lens not only widens the field of view but also corrects the spherical as well as the chromatic aberration, as it is placed beyond the focal distance of the eye-lens (which is the actual eye-piece), and in consequence thereof acts negatively to the same.

This correction, however, is not a complete one, for with the most favorable distance between the two lenses a not inconsiderable remnant of the chromatic aberration still remains, while the spherical aberration is already correspondingly over-corrected. The first is noticeable by the blue edge bordering that side of the object which is turned toward the centre, when the object is placed towards the edge of the field; the remnant of the spherical aberration causes the distortion and want of sharpness of definition at the edge of the field. By increasing the distance between the field-lens and eye-lens the blue color may indeed be made to disappear, but the spherical aberration increases correspondingly, and the field is narrowed considerably. If, on the contrary, the field-lens is brought closer to the eye-lens, the spherical aberration is certainly diminished; but notwithstanding this, the image at the edge of the field does not become any more sharply defined, because the chromatic aberration has increased in equal ratio.

One advantage, however, is gained by approaching the field-lens closer to the eye-lens, namely, a considerable widening of the field.

If, under these circumstances, the aberrations of the eye-lens are cor-

[1] Conducted by DR. R. H. WARD, Troy, N. Y.

rected by suitably composing the same of flint and crown glass, we have an eye-piece which, with all the advantages of the Hughenian eye-piece, surpasses the latter by having a larger field.

These facts form the basis of the construction of the Kellner orthoscopic eye-pieces. Kellner brought the field-lens into the focus of the eye-lens, made the latter achromatic, and chose such curvatures as to remove the spherical aberration and show a flat field, for which latter purpose he also transformed the plano-convex field-lens into a double-convex one.

The simultaneous accomplishment of all these results was favored by the circumstance that in approaching in a Hughenian eye-piece the field-lens to the eye-lens the spherical aberration diminishes more rapidly than the chromatic. The preponderance of the latter over the former in the Hughenian eye-piece must therefore admit of being equalized at a certain point, or rather must accommodate itself at this point to a similar disproportion in the achromatic eye-lens. This point, however, is, as in the Kellner eye-piece, almost exactly the focus of the eye-lens.

A further approach of the field-lens to the eye-lens (bringing the latter within the focus of the former), again gives the preponderance to the chromatic aberration, and an equalization by an achromatic double lens becomes impossible under the circumstances.

If, however, such further approach should be possible without such or other disadvantages, it would be very desirable, not only on account of the enlargement of the field which it would cause, but also on account of the circumstance that when the field-lens is in the exact focus of the eye-lens every fine particle of dust on the former is clearly visible and sharply defined, greatly interfering with the observation.

These facts and considerations caused me to reflect whether a triple eye-lens (consisting of two positive crown-glass lenses and one negative flint-glass) instead of a double lens would not better answer the conditions, and I have in consequence succeeded in forming such a lens which answers the purpose in a very high degree.

My new "periscopic eye-piece" consists of a triple eye-lens, a double-convex field-lens, the latter being situated within the focal distance of the former, and a diaphragm located in the focus of the equivalents of both lenses.

The field of the new eye-piece is considerably larger and flatter than that of Kellner's, and the image is sharply defined to the extreme edge.

As the focus of this eye-piece lies behind the field-lens (the same as in Ramsden's eye-piece), it is particularly suitable for micrometers, especially as the division is distinctly and in correct proportion visible to the extreme edge, which is notably not the case with Ramsden's eye-piece.

A micrometer division placed in the focus of this eye-piece shows, moreover, very perspicuously the high degree of the correction of the aberrations, while the image transmitted by an objective can be no relia-

ble test, as the aberrations of the objective, particularly the distortion, are easily confounded with those of the eye-piece. — E. GUNDLACH.

OBJECTIVES AS ILLUMINATORS. — Mr. George W. Morehouse urges strongly the use of the best attainable objectives as substitutes for the various illuminating accessories furnished with microscopes, on the principle that the illuminator should exactly equal the magnifier in capacity in all respects, which he has not found true of any of the illuminators. By using immersion objectives of the highest angle, properly centred and focused, as achromatic condensers, he believes the truest appearance of the object is obtained, and with the least liability to errors of interpretation, the images of structure lying in different focal planes being separated with the greatest accuracy. Of course, the objects for this use must be mounted in balsam between two thin cover-glasses, or if mounted dry they must be in actual contact with both glasses.

He has also had more than ordinary success with the plan of making the objective its own illuminator for opaque objects, first successfully introduced by Prof. H. L. Smith. He uses the form known as Beck's vertical illuminator, which is a thin glass disk in an adapter above the objective, light from a flat-wicked lamp placed edgeways, at a distance of about eight inches, being reflected by the disk through the objective upon the object. The image of the flame should be seen in the centre of the field, where, with immersion objectives of the highest angle, details of surface structure can be seen with the greatest distinctness with powers as high as four thousand diameters. The projecting spines upon the test podura scales can be thus seen both on the surface and at the edge of the scales; and even objects that only imperfectly reflect the light, such as diatoms, can be distinguished with clearness and beauty. *Pleurosigma angulatum* is seen in hexagons, and *A. pellucida* shows the striæ sharply when the illumination is rendered one-sided by the hand or any other obstruction held partly between the flame and the reflecting disk.

MOUNTING IN DAMMAR. — The occasional failure of specimens mounted in dammar to keep well, by reason of the external ring of varnish running in, or other disaster due to imperfect hardening of the dammar, has led to an interesting and useful discussion in the pages of *Science Gossip*. The best method seems to be to place the object, previously soaked in turpentine or benzole, on the slide, and then either drop the dammar on the object and press down on it the slightly warmed cover-glass, or else place the object from the turpentine on the slide, cover it with the cover-glass, and allow the dammar to flow in assisted by a moderate warmth, — in either case the slide being at once transferred to a metal plate about six inches above the flame of a spirit lamp. As the heat should not be sufficient to boil the dammar, air bubbles will not form, and the progress of the drying need not be closely watched while attending to other work. In about an hour the dammar will be so hardened as to be quite safe, the precise time to remove it from the plate being determined by taking up

on the point of a pin a particle of the superfluous material which has collected at the edge of the cover, which should form, when cold, a globule perfectly hard and not at all sticky.

OPAQUE-GLASS SLIDES. — Mr. Carl Meinerth contributes to the Postal Club a slide having an opaque object mounted on a slide of white porcelain-glass. Some years ago Rev. E. C. Bolles suggested a similar use of black glass for white objects. Both methods make very handsome slides, though for real usefulness we prefer the ordinary slides, as there is scarcely an object on which it might not at some time be desired to pass light through the glass, while a dark background can always be easily secured.

EXCHANGES. — Diatomaceous material containing triceratium wanted in exchange for mounted specimens. Address G. C. Morris, E. Tulpehocken St., Germantown, Philadelphia.

"Plumule" scales of small cabbage butterfly (*Pieris Rapæ*), mounted, for good slides. Address Edward Pennock, 805 Franklin St., Philadelphia.

SCIENTIFIC NEWS.

— As the close season for salmon commences August 1st and extends to November 1st, no more of these fishes will be on sale while they are spawning in our rivers. The law is very stringent against their sale during the season, and makes it a misdemeanor to catch, sell, or have them in possession. — *San Francisco paper.*

— Dispatches of July 2d state that plentiful rains have fallen lately in the famine-stricken districts of Northern China, and the crops are in a flourishing condition. Locusts have, however, appeared in some parts and committed great ravages.

—The Shepard Scientific Collections have recently been purchased by the authorities of Amherst College, at a cost of $40,000, a sum about one half their appraised value. These collections are three in number, a geological, a mineralogical, and a meteoric. The mineralogical collection is one of rare beauty and value, while the meteoric ranks as the fourth in point of size and interest in the world. The college has thus secured some of the most important and valuable collections possessed by any university, either in this country or in Europe. These collections were taken to Amherst from New Haven in 1847, and although deposited by Professor Shepard in the college cabinets at Amherst have hitherto been the property of Professor Shepard.

—Dr. A. B. Meyer, director of the Royal Zoölogical Museum of Dresden, announces his intention to publish figures of rare bird-skeletons, hitherto not at all or insufficiently figured. The work will be issued in parts, containing ten plates each, at intervals of about three months. The price of each part will be fifteen shillings, and the edition limited.

—Messrs. A. O. Hume, C. H. T. and G. F. L. Marshall will shortly

begin the publication of a work on the Game Birds of India, with colored illustrations of all the known species. The work is to be issued in three volumes, and will comprise not only the grouse, bustards, pheasants, jungle fowls, partridges, etc., but also the rails, cranes, swans, geese, ducks, snipes, woodcock, godwits, etc. Price per volume, twenty-one shillings six pence.

—Professor E. S. Morse, of Salem, Mass., is now busy with dredge and microscope in Japan, having fixed his headquarters at Inoshima, seventeen miles south of Yokohama. Recently he ascended one of the highest of the Japanese mountains, about one hundred miles from the coast, and found opportunity there for dredging Lake Chiusenji, a body of water 4000 feet above sea level. Its fauna was ascertained to be quite peculiar. Professor Morse will return to the United States in time for his usual courses of lectures during the coming autumn and winter; but afterwards, in 1878, he expects to go back to Japan, having accepted an engagement in the Imperial University of Tokio, as professor of biology. He has also projected a summer school of natural history, to be conducted on the coast near the university. His text-book for beginners in zoölogy is to be translated into the language of Japan, and animals native to that country are to be substituted for the American ones referred to throughout the volume.

—During the eruption of Cotopaxi, on the 26th of last June, the volcano, according to a writer in the *Nation* of September 6th, poured out a cataract "ten times the bulk of Niagara," which swept away everything before it in its course and submerged a large extent of the surrounding country. The torrent divided and descended in several directions, one branch flowing southerly toward the city of Latacunga, twelve miles distant, but before reaching the city met the beds of three rivers, which carried away the waters and saved it from threatened destruction. The torrent, however, submerged the plain of Callo, and destroyed crops, factories, cattle, and bridges, and it is thought the ruins of the palace of the Incas, described by Humboldt, have not escaped its ravages. Another branch devastated the fertile valley of Chillo, destroying property valued at over two millions of dollars, while the loss of property in other sections is said to be equally great. It is also estimated that the loss of life will exceed one thousand souls. Although the surroundings of Quito were laid waste, the city itself suffered only from a storm of ashes, which fell first in the form of coarse, heavy sand, and later as a fine, impalpable dust, which penetrated everywhere. The darkness was intense for many hours and a reign of terror pervaded the city. It is said that ten years of peace and prosperity, of which there is now in Ecuador faint prospect, will not suffice to repair the evils wrought in a few hours during this memorable eruption.

—News to July 12th received by recent mails fully establishes the connection between the tidal phenomena observed on the northern coast of

Japan on the 11th of May and the disturbances which wrought, almost simultaneously, such destruction on the Peruvian coast, and were unquestionably the cause of the tidal waves, whose effects were noticed in such equally remote places as Hawaii and the eastern shores of the Australian continent.

— In the San Joaquin and other valleys to the southwestward the plains are so parched that the whole surface of the earth presents the appearance of an ash bank. Even the ground-squirrels are deserting the plains and moving up toward the foot-hills in search of food. The Indians regard this migration as indicative of an approaching wet winter. — R. E. C. S.

— Specimens of silver ore recently taken from the Cerro dé Pasco silver mines in Peru show that the submerged portion of the mountain is very rich, and a rough estimate indicates that a body of ore will be exposed by the new tunnel which Meiggs, the South American railroad king, is to build, worth from three hundred million to five hundred million dollars. These mines have laid under water for fifty years, and are scarcely known to the present generation, though they had been worked for two hundred and fifty years, when the miners had to stop on account of the water. Peru has now discovered that a tunnel can be built which will drain the mountain completely by drawing off the lake from which the water in the mine comes; the first loads of the now submerged ore are expected to reach Lima in four months. It is predicted that within ten years more silver will be taken out than from the silver mines in Nevada. This tunnel will in importance be a rival to the famous Sutro tunnel, which is to drain the great Comstock lode of Nevada, though the latter is of much greater extent. — R. E. C. S.

PROCEEDINGS OF SOCIETIES.

The American Association for the Advancement of Science. — The twenty-sixth meeting of the association was held at Nashville, Tenn., beginning August 29th and ending September 4th, — the first gathering of the association in a Southern city for nineteen years. One hundred and seventy members and fellows were in attendance, and about two hundred and twenty new members were elected; thirty were added to the list of fellows. Although the number of fellows and members present was less than at some former meetings, the number of new members added was considerably above the average, and the papers read will compare favorably in point of number and quality with those of previous sessions. The reception tendered by the citizens of Nashville to the association could scarcely have been more cordial or appreciative, while the greatest harmony and good feeling characterized the deliberations of the meetings. The reason for the rather smaller attendance than usual is not far to seek, being evidently due in part to the great

distance of the place of meeting from the homes of most of the members, and to the fact that at this season of great heat the tendency is toward migration in the direction of the pole rather than the equator. The almost unbounded hospitality tendered the association by the authorities and citizens of Nashville and neighboring cities will make the session one long to be remembered by the members whose good fortune it was to be present, while the meeting must tend to stimulate scientific pursuits in the South and cement more closely the lovers of science and learning of all sections. As the president happily remarked in his response to the address of welcome by Judge J. M. Lea (in behalf of the governor of Tennessee, who was necessarily absent), nothing of a political nature estranges from each other the lovers of science, and consequently at this first meeting of the association in a Southern city since internal dissensions so sorely rent our country no reconciliations were necessary. At the close of the meeting of the association the members, by invitation, made an excursion to Chattanooga and Lookout Mountain, a portion of them extending the trip to Central Alabama, reaching Nashville on their return on Saturday, September 8th.

In the absence of the retiring president, Prof. William B. Rogers, the meeting was called to order by Prof. James Hall, who introduced the president-elect, Prof. Simon Newcomb. Owing to illness Professor Rogers had been unable to prepare the customary address expected from the retiring president. The address of the vice-president of Section B (geology and natural history), Prof. O. C. Marsh, on the Introduction and Succession of Vertebrate Life in America, was, from the nature of the subject and the high authority of the author on all matters relating to this important question, *the* event of the natural history section. Passing rapidly over the lower groups, Professor Marsh spoke more particularly of the higher vertebrates, these being the most important witnesses of the past, since through their higher organization they were more susceptible to the influences of slight climatic changes which would otherwise have remained unrecorded. They further possess interest inasmuch as they more closely approach man in their structure, and thus throw light upon his probable origin.

The address of the vice-president of Section A, Prof. E. C. Pickering, who was unable to be present, was read by the temporary chairman, Professor Thurston, the subject being The Endowment of Research. With the man of science there is generally little or no pecuniary reward for his success. Consequently he is obliged to engage in some other occupation, generally teaching, which still allows a little time for research. If these same men were able to devote their entire energies to investigation, and were aided by the necessary appliances, far more would be accomplished. The solution of the matter was organization, the carrying out of a plan by which researches should be rendered as systematic as the process of mechanical arts. A plan was proposed

for an institution for making researches; an ideal building suited to such a purpose was described, and a corps of trained investigators of acknowledged scientific ability, headed by a president and aided by a large body of assistants and workmen, was suggested.

The chairman of the subsection of anthropology, Dr. Daniel Wilson, being also unavoidably absent, his able address on Races in America was read by Permanent Secretary Putnam. The author in this address referred to the rich field America offers to archæologists, and called special attention to subjects of inquiry demanding the closest investigation.

Capt. W. H. Dall, who was appointed last year a committee on zoological nomenclature, presented an elaborate report on this subject. The report was highly commended and referred by vote to the standing committee, with a request for its publication.

Invitations were received to meet next year at St. Louis, Mo., and at St. Paul, Minn. The former place was chosen, where the meeting will open August 21, 1878. The following general officers were elected for the next meeting: president, Prof. O. C. Marsh, of New Haven; vice-president of Section A, Prof. R. H. Thurston, of Hoboken, N. J.; vice-president of Section B, A. R. Grote, of Buffalo, N. Y.; chairman of the sub-section of chemistry, Prof. F. W. Clarke, of Cincinnati, O.; chairman of the sub-section of microscopy, Dr. G. S. Blackie, of Nashville, Tenn.; permanent secretary, F. W. Putnam, of Cambridge; general secretary, Dr. H. Carrington Bolton, of Hartford, Conn.; secretary of Section A, F. E. Nipher, of St. Louis, Mo.; secretary of Section B, Dr. George Little, of Atlanta, Ga.; treasurer, William S. Vaux, of Philadelphia, Pa.

The following is a list of the papers read relating to geology, zoölogy, botany, anthropology, and microscopy: Aug. R. Grote, Our Knowledge of the Cotton Worm; A New Lepidopterous Insect Injurious to Vegetation; An International Scientific Survey; J. W. Powell, The Structure of Eruptive Mountains; William Bross, All Life conditionally Immortal; Thomas Meehan, On Sex in Flowers; Miss Virginia K. Bowers, The Law of Repetition; Burt G. Wilder, On the Respiration of Amia; Homer F. Basset, Agamous Reproduction among the Cynipidæ; N. S. Shaler, On the Original Connection of the Eastern and Western Coal-Fields of the Ohio Valley; On the Continuation of the Folds of the Alleghany Chain to the North of the Delaware River; A. C. Campbell, On the Mechanics of the Flight of Birds; Mrs. H. R. Ingram, Atmospheric Concussion as a Means of Disinfection; J. M. Safford, On the Silurian Island of the Cincinnati Uplift with Reference to its Past in Tennessee; N. S. Shaler, On the Geographical and Geological Distribution of the Genus Beatricea, and of Certain Other Fossil Corals in the Rocks of the Cincinnati Group; T. O. Summers, Jr., Some Observations on the Skull of the Comanche; E. D. Cope, On the Classification of the Extinct Fishes of the Lower Types; J. W. Powell, Overplacement;

N. S. Shaler, On the Recent Formation of a Small Anticlinal Axis in Lincoln County, Kentucky; E. D. Cope, On the Origin of Structural Variation; A. R. Grote and W. H. Pitt, New Specimens from the Water Lime Group at Buffalo; Samuel J. Wallace, On Geodes and Other Fossiloids; James E. Todd, On the Annual Deposits of the Missouri River during the Post-Pliocene; Ernst Gundlach, A New Periscopic Eye-Piece; Alexis A. Julien, Accessories adapted to Lithological Investigation; George W. Morehouse, Objectives as Illuminators; C. Leo Mees, On the Use of Ordinary Low-Power Objectives for Photography; R. H. Ward, On the Cellular Structure of Dentine; On a Modification of Wenham's Reflex Illuminator; T. O. Summers, Jr., On the Relative Values of the Powers of Objectives and Eye-Pieces; T. Sterry Hunt, Notes on the Silurian Waters of Washoe, Nevada; Shuze Isawa, On the Origin of the Japanese; Garrick Mallery, The Former and Present Numbers of our Indians; Henry Gillman, Additional Facts concerning Artificial Perforations of the Cranium in Ancient Mounds in Michigan; Edwin A. Barber, Habits of the Moqui Tribe; J. W. Powell, Some Popular Errors concerning the North American Indians; Alexis A. Julien, On the Ancient Excavations of Western North Carolina; H. N. Rust, Report on the Exploration of the Graves of the Mound Builders in Scott and Mississippi Counties, Missouri; J. W. Powell, Introduction to the Study of Indian Languages; Joseph B. Killebrew, Geology and Topography of the Oil Regions of Tennessee and the Oil Springs and Wells; T. Sterry Hunt, Notes on the Geology of the Rocky Mountains; James M. Safford, Notes of a Specimen of Cyrtodonta ventricosa from the Lower Silurian; A. E. Wetherby, The Variation of Certain Fresh-Water Mollusks of the United States, and their Geographical Distribution; J. H. Huntington, Geology of the Region on the Head Waters of the Androscoggin River; E. D. Cope, On the Characters of a New Cretaceous Saurian from the Rocky Mountains; E. L. Drake, A Section of McKinny Hill, Tennessee; B. S. Hedrick, On the Use to be made of Post Route Maps in the Advancement of Science: E. T. Cox, Geological Position and Mode of Origin of Hydrated Brown Oxide of Iron; R. L. Kirkpatrick, On the Relation of Organ to Function, or of Form in General to Mode of Energy received and exerted; James A. Ridley, On the Fibre of Gossypium herbaceum (cotton plant) considered with Reference to a Practical Application of its Manufacture.

SCIENTIFIC SERIALS.[1]

THE GEOLOGICAL MAGAZINE. — August. Across Europe and Asia. Traveling Notes (Part II.), St. Petersburg to Perm, by John Milne. A Sketch of the Geology of Keighley, Skipton, and Grassington, by J. R. Dakyns. Notes on the Correlation of the Beds

[1] The articles enumerated under this head will be for the most part selected.

constituting the Upper Greensand and Chloritic Marl, by A. J. Fukes Browne.

THE GEOGRAPHICAL MAGAZINE. — August. The Arctic Expedition, xvii. Refutation of the Assertions of Hostile Critics. The Bengal Cyclone of 1876. Affairs in Japan, by R. H. Brunton. The Livingstonia Mission, by J. Thornton Macklin and J. Stewart. The Great Earthquake on the Coast of Peru of May 9, 1877. Exploration in Patagonia, by F. P. Moreno. The India-Rubber Trees in Brazil, by Robert Cross.

SCIENCE GOSSIP. — August. A Sketch of the Geology of Plymouth and the Neighborhood (illustrated). Botanical Notes in the Neighborhood of Cader-Idris. The Seals and Whales of the British Seas, No. 3 (illustrated). Another Sketch in the West of Ireland (illustrated). The Economical Products of Plants (illustrated). A Microscopical Slide-Box (illustrated).

MICROSCOPICAL JOURNAL. — August. A Simple Device for the Illumination of Balsam-Mounted Objects for Examination with Certain Immersion Objectives whose "Balsam Angle" is ninety degrees or upwards, by J. J. Woodward. An Essay on the Classification of the Diatomaceæ, by M. Paul Petit, translated by F. Kilton. Note on a New Paraboloid Illuminator for Use beneath the Microscope Stage. Also Note on the Resolution of Podura Scale by Means of the New Paraboloid, by James Edwards. The Development of the Ovum, by W. N. Dallinger and J. Drysdale. German Methods in Histology and Embryology, by Charles Sedgwick Minot.

AMERICAN JOURNAL OF SCIENCE AND ARTS. — September. Notes on the Internal and External Structure of Palæozoic Crinoids, by C. Wachsmuth. Phenomena of Binocular Vision, by J. LeConte. The Relation of the Geology of Vermont to that of Berkshire, by J. D. Dana. Notice of a New Genus of Annelids from the Lower Silurian, by G. B. Grinnell. New Vertebrate Fossils, by O. C. Marsh.

BULLETIN OF THE UNITED STATES GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES. — Vol. iii., No. 4. The First Discovered Traces of Fossil Insects in the American Tertiaries, by Samuel H. Scudder. Description of Two Species of Carabidæ found in the Interglacial Deposits of Scarboro Heights, near Toronto, Canada, by Samuel H. Scudder. Report upon the Insects collected by P. R. Uhler during the Explorations of 1875, including Monographs of the Families Cydnidæ and Saldæ, and the Hemiptera collected by A. S. Packard, Jr., M. D., by P. R. Uhler. Description of Cambarus Couesi, a New Species of Crawfish from Dakota, by Thomas H. Streets, M. D. U. S. N. On a Carnivorous Dinosaurian from the Dakota Beds of Colorado, by E. D. Cope. A Contribution to the Knowledge of the Ichthyological Fauna of the Green River Shales, by E. D. Cope. On the Genus Erisichthe, by E. D. Cope.

THE

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THE COLORS OF ANIMALS AND PLANTS.[1]

BY ALFRED RUSSEL WALLACE.

I. THE COLORS OF ANIMALS.

THERE is probably no one quality of natural objects from which we derive so much pure and intellectual enjoyment as from their colors. The "heavenly" blue of the firmament, the glowing tints of sunset, the exquisite purity of the snowy mountains, and the endless shades of green presented by the verdure-clad surface of the earth, are a never-failing source of pleasure to all who enjoy the inestimable gift of sight. Yet these constitute, as it were, but the frame and background of a marvelous and ever-changing picture. In contrast with these broad and soothing tints, we have presented to us, in the vegetable and animal worlds, an infinite variety of objects adorned with the most beautiful and most varied hues. Flowers, insects, and birds are the organisms most generally ornamented in this way; and their symmetry of form, their variety of structure, and the lavish abundance with which they clothe and enliven the earth cause them to be objects of universal admiration. The relation of this wealth of color to our mental and moral nature is indisputable. The child and the savage alike admire the gay tints of flower, bird, and insect; while to many of us their contemplation brings a solace and enjoyment which is both intellectually and morally beneficial. It can then hardly excite surprise that this relation was long thought to afford a sufficient explanation of the phenomena of color in nature, and although the fact that

"Full many a flower is born to blush unseen,
And waste its sweetness on the desert air"

might seem to throw some doubt on the sufficiency of the explanation, the answer was easy: that, in the progress of discovery,

[1] From Macmillan's Magazine.

man would, sooner or later, find out and enjoy every beauty that the hidden recesses of the earth have in store for him. This theory received great support from the difficulty of conceiving any other use or meaning in the colors with which so many natural objects are adorned. Why should the homely gorse be clothed in golden raiment, and the prickly cactus be adorned with crimson bells? Why should our fields be gay with buttercups, and the heather-clad mountains be clad in purple robes? Why should every land produce its own peculiar floral gems, and the Alpine rocks glow with beauty, if not for the contemplation and enjoyment of man? What could be the use to the butterfly of its gayly-painted wings, or to the humming-bird of its jeweled breast, except to add the final touches to a world picture, calculated at once to please and to refine mankind? And even now, with all our recently acquired knowledge of this subject, who shall say that these old-world views were not intrinsically and fundamentally sound, and that although we now know that color has "uses" in nature that we little dreamed of, yet the relation of those colors to our senses and emotions may be another and perhaps more important use which they subserve in the great system of the universe?

We now propose to lay before our readers a general account of the more recent discoveries on this interesting subject, and, in doing so, it will be necessary, first, to give an outline of the more important facts as to the colors of organized beings; then, to point out the cases in which it has been shown that color is of use; and, lastly, to endeavor to throw some light on its nature and the general laws of its development.

Among naturalists color was long thought to be of little import, and to be quite untrustworthy as a specific character. The numerous cases of variability of color led to this view. The occurrence of white blackbirds, white peacocks, and black leopards, of white bluebells, and of white, blue, or pink milkworts led to the belief that color was essentially unstable; that it could therefore be of little or no importance, and belonged to quite a different class of characters from form or structure. But it now begins to be perceived that these cases, though tolerably numerous, are, after all, exceptional, and that color, as a rule, is a constant character. The great majority of species, both of animals and plants, are each distinguished by peculiar tints which vary very little, while the minutest markings are often constant in thousands or millions of individuals. All our field buttercups are

invariably yellow, and our poppies red, while many of our butterflies and birds resemble each other in every spot and streak of color through thousands of individuals. We also find that color is constant in whole genera and other groups of species. The Genistas are all yellow, the Erythrinas all red; many genera of Carabidæ are entirely black; whole families of birds — as the Dendrocolaptidæ — are brown; while among butterflies the numerous species of Lycæna are all more or less blue, those of Pontia white, and those of Callidryas yellow. An extensive survey of the organic world thus leads us to the conclusion that color is by no means so unimportant or inconstant a character as at first sight it appears to be; and the more we examine it the more convinced we shall become that it must serve some purpose in nature, and that besides charming us by its diversity and beauty it must be well worthy of our attentive study, and have many secrets to unfold to us.

In order to group the great variety of facts relating to the colors of the organic world in some intelligible way, it will be best to consider how far the chief theories already proposed will account for them. One of the most obvious and most popular of these theories, and one which is still held, in part at least, by many eminent naturalists, is that color is due to some direct action of the heat and light of the sun, thus at once accounting for the great number of brilliant birds, insects, and flowers which are found between the tropics. But here we must ask whether it is really the fact that color is more developed in tropical than in temperate climates in proportion to the whole number of species; and, even if we find this to be so, we have to inquire whether there are not so many and such striking exceptions to the rule as to indicate some other causes at work than the direct influence of solar light and heat. As this is a most important question we must go into it somewhat fully.

It is undoubtedly the case that there are an immensely greater number of richly-colored birds and insects in tropical than in temperate and cold countries; but it is by no means so certain that the *proportion* of colored to obscure species is much or any greater. Naturalists and collectors well know that the majority of tropical birds are dull colored; and there are whole families, comprising hundreds of species, not one of which exhibits a particle of bright color. Such are the Timaliidæ of the eastern and the Dendrocolaptidæ of the western hemisphere. Again, many groups of birds, which are universally distributed, are no more

adorned with color in the tropical than in the temperate zone: such are thrushes, wrens, goat-suckers, hawks, grouse, plovers, and snipe; and if tropical light and heat have any direct coloring effect, it is certainly most extraordinary that in groups so varied in form, structure, and habits as those just mentioned the tropical should be in no wise distinguished in this respect from the temperate species. The brilliant tropical birds mostly belong to groups which are wholly or almost wholly tropical, as the chatterers, toucans, trogons, and pittas; but as there are, perhaps, an equal number of groups which are wholly dull colored, while others contain dull and bright colored species in nearly equal proportions, the evidence is by no means strong that tropical light or heat has anything to do with the matter. But there are also groups in which the cold and temperate zones produce finer-colored species than the tropics. Thus the arctic ducks and divers are handsomer than those of the tropical zone, while the king duck of temperate America and the mandarin duck of Northern China are the most beautifully colored of the whole family. In the pheasant family we have the gorgeous gold and silver pheasants in Northern China and Mongolia, and the superb impeyan pheasant in the temperate Northwest Himalayas, as against the peacocks and fire-backed pheasants of tropical Asia. Then we have the curious fact that most of the bright-colored birds of the tropics are denizens of the forests, where they are shaded from the direct light of the sun, and that they abound near the equator, where cloudy skies are very prevalent; while, on the other hand, places where light and heat are at a maximum have often dull-colored birds. Such are the Sahara and other deserts, where almost all the living things are sand colored; but the most curious case is that of the Galapagos Islands, situated under the equator and not far from South America, where the most gorgeous colors abound, but which are yet characterized by prevailing dull and sombre tints in birds, insects, and flowers, so that they reminded Mr. Darwin of the cold and barren plains of Patagonia. Insects are wonderfully brilliant in tropical countries generally, and any one looking over a collection of South American or Malayan butterflies would scout the idea of their being no more gayly colored than the average of European species, and in this they would be undoubtedly right. But on examination we should find that all the more brilliantly colored groups were exclusively tropical, and that where a genus has a wide range there is little difference in color-

ation between the species of cold and warm countries. Thus the European Vanessides, including the beautiful "peacock," "Camberwell beauty," and "red admiral" butterflies, are quite up to the average of tropical beauty in the same group, and the remark will equally apply to the little "blues" and "coppers;" while the Alpine "Apollo" butterflies have a delicate beauty that can hardly be surpassed. In other insects, which are less directly dependent on climate and vegetation, we find even greater anomalies. In the immense family of the Carabidæ or predaceous ground-beetles the northern forms fully equal, if they do not surpass, all that the tropics can produce. Everywhere, too, in hot countries, there are thousands of obscure species of insects which, if they were all collected, would not improbably bring down the average of color to much about the same level as that of temperate zones.

But it is when we come to the vegetable world that the greatest misconception on this subject prevails. In abundance and variety of floral color the tropics are almost universally believed to be preëminent, not only absolutely, but relatively to the whole mass of vegetation and the total number of species. Twelve years of observation among the vegetation of the eastern and western tropics has, however, convinced me that this notion is entirely erroneous, and that, in proportion to the whole number of species of plants, those having gayly colored flowers are actually more abundant in the temperate zones than between the tropics. This will be found to be not so extravagant an assertion as it may at first appear if we consider how many of the choicest adornments of our greenhouses and flower shows are really temperate as opposed to tropical plants. The masses of color produced by our rhododendrons, azaleas, and camellias, our pelargoniums, calceolarias, and cinerarias, — all strictly temperate plants, — can certainly not be surpassed, if they can be equaled, by any productions of the tropics.[1] But we may go further, and say that the

[1] It may be objected that most of the plants named are choice, cultivated *varieties*, far surpassing in color the original stock, while the tropical plants are mostly unvaried wild *species*. But this does not really much affect the question at issue. For our florists' gorgeous varieties have all been produced under the influence of our cloudy skies, and with even a still further deficiency of light, owing to the necessity of protecting them under glass from our sudden changes of temperature, so that they are themselves an additional proof that tropical light and heat are not needed for the production of intense and varied color. Another important consideration is that these cultivated *varieties* in many cases displace a number of wild *species* which are hardly, if at all, cultivated. Thus there are scores of *species* of wild hollyhocks varying in color almost as much as the cultivated varieties, and the same may be said of the

hardy plants of our cold temperate zone equal if they do not surpass the productions of the tropics. Let us only remember such gorgeous tribes of flowers as the roses, peonies, hollyhocks, and antirrhinums, the laburnum, Wistaria, and lilac, the lilies, irises, and tulips, the hyacinths, anemones, gentians, and poppies, and even our humble gorse,* broom, and heather; and we may defy any tropical country to produce masses of floral color in greater abundance and variety. It may be true that individual tropical shrubs and flowers do surpass everything in the rest of the world, but that is to be expected, because the tropical zone comprises a much greater land area than the two temperate zones, while, owing to its more favorable climate, it produces a still larger proportion of species of plants and a great number of peculiar natural orders.

Direct observation in tropical forests, plains, and mountains fully supports this view. Occasionally we are startled by some gorgeous mass of color, but as a rule we gaze upon an endless expanse of green foliage, only here and there enlivened by not very conspicuous flowers. Even the orchids, whose gorgeous blossoms adorn our stoves, form no exception to this rule. It is only in favored spots that we find them in abundance; the species with small and inconspicuous flowers greatly preponderate, and the flowering season of each kind being of short duration they rarely produce any marked effect of color amid the vast masses of foliage which surround them. An experienced collector in the eastern tropics once told me that although a single mountain in Java had produced three hundred species of Orchideæ only about two per cent. of the whole were sufficiently ornamental or showy to be worth sending home as a commercial speculation. The Alpine meadows and rock slopes, the open plains of the Cape of Good Hope or of Australia, and the flower prairies of North America offer an amount and variety of floral color which can certainly not be surpassed even if it can be equaled between the tropics.

It appears, therefore, that we may dismiss the theory that the development of color in nature is directly dependent on, and in any way proportioned to, the amount of solar heat and light as entirely unsupported by facts. Strange to say, however, there

pentstemons, rhododendrons, and many other flowers; and if these were all brought together in well-grown specimens they would produce a grand effect. But it is far easier and more profitable for our nursery-men to grow *varieties* of one or two species, which all require a very similar culture, rather than fifty distinct *species*, most of which would require special treatment, the result being that the varied beauty of the temperate flora is even now hardly known except to botanists and to a few amateurs.

are some rare and little-known phenomena which prove that, in exceptional cases, light does directly affect the colors of natural objects, and it will be as well to consider these before passing on to other matters.

A few years ago Mr. T. W. Wood called attention to the curious changes in the color of the chrysalis of the small cabbage butterfly (*Pontia rapæ*), when the caterpillars were confined in boxes lined with different tints. Thus in black boxes they were very dark, in white boxes nearly white; and he further showed that similar changes occurred in a state of nature, chrysalises fixed against a whitewashed wall being nearly white, against a red-brick wall reddish, against a pitched paling nearly black. It has also been observed that the cocoon of the emperor moth is either white or brown, according to the surrounding colors. But the most extraordinary example of this kind of change is that furnished by the chrysalis of an African butterfly (*Papilio Nireus*), observed at the Cape by Mrs. Barber, and described (with a colored plate) in the Transactions of the Entomological Society, 1874, page 519. The caterpillar feeds on the orange-tree, and also on a forest tree (*Vepris lanceolata*) which has a lighter green leaf, and its color corresponds with that of the leaves it feeds upon, being of a darker green when it feeds on the orange. The chrysalis is usually found suspended among the leafy twigs of its food-plant or of some neighboring tree, but it is probably often attached to larger branches; and Mrs. Barber has discovered that it has the property of acquiring the color, more or less accurately, of any natural object it may be in contact with. A number of the caterpillars were placed in a case with a glass cover, one side of the case being formed by a red-brick wall, the other sides being of yellowish wood. They were fed on orange leaves, and a branch of the bottle-brush tree (*Banksia*, sp.) was also placed in the case. When fully fed some attached themselves to the orange twigs, others to the bottle-brush branch, and these all changed to green pupæ, but each corresponded exactly in tint to the leaves around it, the one being dark, the other a pale, faded green. Another attached itself to the wood, and the pupa became of the same yellowish color; while one fixed itself just where the wood and brick joined, and became one side red, the other side yellow! These remarkable changes would perhaps not have been credited had it not been for the previous observations of Mr. Wood; but the two support each other, and

oblige us to accept them as actual phenomena. It is a kind of natural photography, the particular colored rays to which the fresh pupa is exposed in its soft, semi-transparent condition effecting such a chemical change in the organic juices as to produce the same tint in the hardened skin. It is interesting, however, to note that the range of color that can be acquired seems to be limited to those of natural objects to which the pupa is likely to be attached; for when Mrs. Barber surrounded one of the caterpillars with a piece of scarlet cloth no change of color at all was produced, the pupa being of the usual green tint, but the small red spots with which it is marked were brighter than usual.

In these caterpillars and pupæ, as well as in the great majority of cases in which a change of color occurs in animals, the action is quite involuntary; but among some of the higher animals the color of the integument can be modified at the will of the animal, or, at all events, by a reflex action dependent on sensation. The most remarkable case of this kind occurs with the chameleon, which has the power of changing its color from dull white to a variety of tints. This singular power has been traced to two layers of pigment deeply seated in the skin, from which minute tubes or capillary vessels rise to the surface. The pigment layers are bluish and yellowish, and by the pressure of suitable muscles these can be forced upward either together or separately. When no pressure is exerted the color is dirty white, which changes to various tints of bluish, green, yellow, or brown, as more or less of either pigment is forced up and rendered visible. The animal is excessively sluggish and defenseless, and its power of changing its color to harmonize with surrounding objects is essential to its existence. Here, too, as with the pupa of *Papilio Nireus*, colors such as scarlet or blue, which do not occur in the immediate environment of the animal, cannot be produced. Somewhat similar changes of color occur in some prawns and flat-fish, according to the color of the bottom on which they rest. This is very striking in the chameleon shrimp (*Mysis chamæleon*), which is gray when on sand, but brown or green when among sea-weed of these two colors. Experiment shows, however, that when blinded the change does not occur, so that here, too, we probably have a voluntary or reflex sense-action. Many cases are known among insects in which the same species has a different tint according to its surroundings, this being particularly marked in some South African locusts which correspond with

the color of the soil wherever they are found, while several caterpillars which feed on two or more plants vary in color accordingly. Several such changes are quoted by Mr. R. Meldola in a paper on Variable Protective Coloring in Insects,[1] and some of them may perhaps be due to a photographic action of the reflected light. In other cases, however, it has been shown that green chlorophyll remains unchanged in the tissues of leaf-eating insects, and being discernible through the transparent integument produces the same color as that of the food plant.

These peculiar powers of change of color and adaptation are, however, rare and quite exceptional. As a rule there is no direct connection between the colors of organisms and the kind of light to which they are usually exposed. This is well seen in most fishes and in such marine animals as porpoises, whose backs are always dark, although this part is exposed to the blue and white light of the sky and clouds, while their bellies are very generally white, although these are constantly subjected to the deep-blue or dusky-green light from the bottom. It is evident, however, that these two tints have been acquired for concealment and protection. Looking *down* on the dark back of a fish it is almost invisible, while to an enemy looking *up* from below, the light under surface would be equally invisible against the light of the clouds and sky. Again, the gorgeous colors of the butterflies which inhabit the depths of tropical forests bear no relation to the kind of light that falls upon them, coming as it does almost wholly from green foliage, dark-brown soil, or blue sky; and the bright under wings of many moths, which are exposed only at night, contrast remarkably with the sombre tints of the upper wings, which are more or less exposed to the various colors of surrounding nature.

We find, then, that neither the general influence of solar light and heat nor the special action of variously-tinted rays are adequate causes for the wonderful variety, intensity, and complexity of the colors that everywhere meet us in the animal and vegetable world. Let us, therefore, take a wider view of these colors, grouping them into classes determined by what we know of their actual uses or special relations to the habits of their possessors. This, which may be termed the functional or biological classification of the colors of living organisms, seems to be best expressed by a division into five groups, as follows: —

[1] Proceedings of the Zoölogical Society of London, 1873, page 153.

Animals.	1. Protective colors.	
	2. Warning colors.	*a.* Of creatures specially protected.
		b. Of defenseless creatures, mimicking *a.*
	3. Sexual colors.	
	4. Typical colors.	
Plants.	5. Attractive colors	

The nature of the first two groups, protective and warning colors, has been so fully detailed and illustrated in my chapter on Mimicry and other Protective Resemblances among Animals [1] that very little need be added here except a few words of general explanation. Protective colors are exceedingly prevalent in nature, comprising those of all the white arctic animals, the sandy-colored desert forms, and the green birds and insects of tropical forests. It also comprises thousands of cases of special resemblance, — of birds to the surroundings of their nests, and especially of insects to the bark, leaves, flowers, or soil, on or amid which they dwell. Mammalia, fishes, and reptiles, as well as mollusca and other marine invertebrates, present similar phenomena; and the more the habits of animals are investigated, the more numerous are found to be the cases in which their colors tend to conceal them, either from their enemies or from the creatures they prey upon. One of the last-observed and most curious of these protective resemblances has been communicated to me by Sir Charles Dilke. He was shown in Java a pink-colored *Mantis*, which, when at rest, exactly resembled a pink orchis flower. The Mantis is a carnivorous insect which lies in wait for its prey, and by its resemblance to a flower the insects it feeds on would be actually attracted toward it. This one is said to feed especially on butterflies, so that it is really a living trap and forms its own bait! All who have observed animals, and especially insects, in their native haunts and attitudes can understand how it is that an insect which in a cabinet looks exceedingly conspicous may yet, when alive, in its peculiar attitude of repose and with its habitual surroundings, be perfectly well concealed. We can hardly ever tell, by the mere inspection of an animal, whether its colors are protective or not. No one would imagine the exquisitely beautiful caterpillar of the emperor moth, which is green with pink, star-like spots, to be protectively colored; yet when feeding on the heather it so harmonizes with the foliage and flowers as to be almost invisible. Every day fresh cases of protective coloring are being discovered even in our own country, and it is becoming more and more evident that the need of protection has played a very important part in determining the actual coloration of animals.

[1] Contributions to the Theory of Natural Selection, page 45.

The second class — the warning colors — are exceedingly interesting, because the object and effect of these is, not to conceal the object, but to make it conspicuous. To these creatures it is *useful* to be seen and recognized, the reason being that they have a means of defense which, if known, will prevent their enemies from attacking them, though it is generally not sufficient to save their lives if they are actually attacked. The best examples of these specially protected creatures consist of two extensive families of butterflies, the Danaidæ and Acræidæ, comprising many hundreds of species inhabiting the tropics of all parts of the world. These insects are generally large, are all conspicuously and often most gorgeously colored, presenting almost every conceivable tint and pattern; they all fly slowly, and they never attempt to conceal themselves; yet no bird, spider, lizard, or monkey (all of which eat other butterflies) ever touches them. The reason simply is that they are not fit to eat, their juices having a powerful odor and taste that is absolutely disgusting to all these animals. Now, we see the reason of their showy colors and slow flight. It is good for them to be seen and recognized, for then they are never molested; but if they did not differ in form and coloring from other butterflies, or if they flew so quickly that their peculiarities could not be easily noticed, they would be captured, and though not eaten would be maimed or killed. As soon as the cause of the peculiarities of these butterflies was recognized, it was seen that the same explanation applied to many other groups of animals. Thus bees and wasps and other stinging insects are showily and distinctively colored; many soft and apparently defenseless beetles, and many gay-colored moths, were found to be as nauseous as the above-named butterflies; other beetles, whose hard and glossy coats of mail render them unpalatable to insect-eating birds, are also sometimes showily colored; and the same rule was found to apply to caterpillars, all the brown and green (or protectively colored species) being greedily eaten by birds, while showy kinds, which never hide themselves, — like those of the magpie, mullein, and burnet moths, — were utterly refused by insectivorous birds, lizards, frogs, and spiders.[1] Some few analogous examples are found among vertebrate animals. I will only mention here a very interesting case not given in my former work. In his delightful book entitled The Naturalist in Nicaragua, Mr. Belt tells us that there is in that country a frog which is very abundant, which hops about in the day-time, which

[1] Contributions to Theory of Natural Selection, page 117.

never hides himself, and which is gorgeously colored with red and blue. Now, frogs are usually green, brown, or earth-colored, feed mostly at night, and are all eaten by snakes and birds. Having full faith in the theory of protective and warning colors, to which he had himself contributed some valuable facts and observations, Mr. Belt felt convinced that this frog must be uneatable. He therefore took one home, and threw it to his ducks and fowls; but all refused to touch it except one young duck, which took the frog in its mouth, but dropped it directly, and went about jerking its head as if trying to get rid of something nasty. Here the uneatableness of the frog was predicted from its colors and habits, and we can have no more convincing proof of the truth of the theory than such previsions.

The universal avoidance by carnivorous animals of all these specially protected groups, which are thus entirely free from the constant persecution suffered by other creatures not so protected, would evidently render it advantageous for any of these latter which were subjected to extreme persecution to be mistaken for the former, and for this purpose it would be necessary that they should have the same colors, form, and habits. Strange to say, wherever there is an extensive group of directly protected forms (division *a* of animals with warning colors) there are sure to be found a few otherwise defenseless creatures which resemble them externally so as to be mistaken for them, and which thus gain protection as it were on false pretenses (division *b* of animals with warning colors). This is what is called "mimicry," and it has already been very fully treated of by Mr. Bates (its discoverer), by myself, by Mr. Trimen, and others. Here it is only necessary to state that the uneatable Danaidæ and Acræidæ are accompanied by a few species of other groups of butterflies (Leptalidæ, Papilios, Diademas, and Moths) which are all really eatable, but which escape attack by their close resemblance to some species of the uneatable groups found in the same locality. In like manner there are a few eatable beetles which exactly resemble species of uneatable groups; and others, which are soft, imitate those which are uneatable through their hardness. For the same reason wasps are imitated by moths, and ants by beetles; and even poisonous snakes are mimicked by harmless snakes, and dangerous hawks by defenseless cuckoos. How these curious imitations have been brought about, and the laws which govern them, have been discussed in the work already referred to.

The third class — sexual colors — comprise all cases in which

the colors of the two sexes differ. This difference is very general, and varies greatly in amount, from a slight divergence of tint up to a radical change of coloration. Differences of this kind are found among all classes of animals in which the sexes are separated, but they are much more frequent in some groups than in others. In mammalia, reptiles, and fishes, they are comparatively rare and not great in amount, whereas among birds they are very frequent and very largely developed. So among insects, they are abundant in butterflies, while they are comparatively uncommon in beetles, wasps, and hemiptera.

The phenomena of sexual variations of color, as well as of color generally, are wonderfully similar in the two analogous yet totally unrelated groups of birds and butterflies; and, as they both offer ample materials, we shall confine our study of the subject chiefly to them. The most common case of difference of color between the sexes is for the male to have the same general hue as the females, but deeper and more intensified, as in many thrushes, finches, and hawks, and among butterflies in the majority of our British species. In cases where the male is smaller the intensification of color is especially well pronounced, as in many of the hawks and falcons, and in most butterflies and moths in which the coloration does not materially differ. In another extensive series we have spots or patches of vivid color in the male which are represented in the female by far less brilliant tints, or are altogether wanting, as exemplified in the gold-crest warbler, the green woodpecker, and most of the orange-tip butterflies (*Anthocharis*). Proceeding with our survey we find greater and greater differences of color in the sexes, till we arrive at such extreme cases as some of the pheasants, the chatterers, tanagers, and birds-of-paradise, in which the male is adorned with the most gorgeous and vivid colors, while the female is usually dull brown or olive-green, and often shows no approximation whatever to the varied tints of her partner. Similar phenomena occur among butterflies; and in both these classes there are also a considerable number of cases in which both sexes are highly colored in a different way. Thus many woodpeckers have the head in the male red, in the female yellow; while some parrots have red spots in the male, replaced by blue in the female, as in *Psittacula diopthalma.* In many South American papilios green spots on the male are represented by red on the female; and in several species of the genus *Epicalia* orange bands in the male are replaced by blue in the female, a similar change of color as in the

small parrot above referred to. For fuller details of the varieties of sexual coloration we refer our readers to Mr. Darwin's Descent of Man, chapters x. to xviii., and to chapters iii., iv., and vii., of my Contributions to the Theory of Natural Selection.

The fourth group — of typically-colored animals — includes all species which are brilliantly or conspicuously colored in both sexes, and for whose particular colors we can assign no function or use. It comprises an immense number of showy birds, such as kingfishers, barbets, toucans, lories, tits, and starlings; among insects most of the largest and handsomest butterflies, innumerable bright-colored beetles, locusts, dragon-flies, and hymenoptera; a few mammalia, as the zebras; a great number of marine fishes; thousands of striped and spotted caterpillars; and abundance of mollusca, star-fish, and other marine animals. Among these we have included some which, like the gaudy caterpillars, have warning colors; but as that theory does not explain the particular colors or the varied patterns with which they are adorned, it is best to include them also in this class. It is a suggestive fact that all the brightly colored birds mentioned above build in holes or form covered nests, so that the females do not need that protection during the breeding season, which I believe to be one of the chief causes of the dull color of female birds when their partners are gayly colored. This subject is fully argued in my Contributions, etc., chapter vii.

As the colors of plants and flowers are very different from those of animals, both in their distribution and functions, it will be well to treat them separately: we will therefore now consider how the general facts of color here sketched out can be explained. We have first to inquire what is color, and how it is produced; what is known of the causes of change of color; and what theory best accords with the whole assemblage of facts.

The sensation of color is caused by vibrations or undulations of the ethereal medium of different lengths and velocities. The whole body of vibrations caused by the sun is termed radiation, and consists of sets of waves which vary considerably in their dimensions and their rate of vibration, but of which the middle portion only is capable of exciting in us sensations of light and color. Beginning with the largest and slowest rays or wave vibrations, we have first those which produce heat sensations only; as they get smaller and quicker, we perceive a dull-red color; and as the waves increase in rapidity of vibration and diminish in size, we get successively sensations of orange, yellow, green,

blue, indigo, and violet, all fading imperceptibly into each other. Then come more invisible rays, of shorter wave-length and quicker vibration, which produce, solely or chiefly, chemical effects. The red rays, which first become visible, have been ascertained to vibrate at the rate of four hundred and fifty-eight millions of millions of times in a second, the length of each wave being $\frac{1}{35900}$ of an inch; while the violet rays, which last remain visible, vibrate seven hundred and twenty-seven millions of millions of times per second, and have a wave-length of $\frac{1}{54615}$ of an inch. Although the waves vibrate at different rates, they are all propagated through the ether with the same velocity (192,000 miles per second), just as different musical sounds, which are produced by waves of *air* of different lengths and rates of vibration, travel at the same rate, so that a tune played several hundred yards off reaches the ear in correct time. There are, therefore, an almost infinite number of different color-producing vibrations, and these may be combined in an almost infinite variety of ways, so as to excite in us the sensation of all the varied colors and tints we are capable of perceiving. When all the different kinds of rays reach us in the proportion in which they exist in the light of the sun, they produce the sensation of white. If the rays which excite the sensation of any one color are prevented from reaching us, the remaining rays in combination produce a sensation of color often very far removed from white. Thus green rays being abstracted leave purple light; blue, orange-red light; violet, yellowish-green light; and so on. These pairs are termed complementary colors. And if portions of differently colored lights are abstracted in various degrees, we have produced all those infinite gradations of colors, and all those varied tints and hues, which are of such use to us in distinguishing external objects, and which form one of the great charms of our existence. Primary colors would therefore be as numerous as the different wave-lengths of the visible radiations, if we could appreciate all their differences; while secondary or compound colors, caused by the simultaneous action of any combination of rays of different wave-lengths, must be still more numerous. In order to account for the fact that all colors appear to us capable of being produced by combinations of three primary colors, — red, green, and violet, — it is believed that we have three sets of nerve fibres in the retina, each of which is capable of being excited by all rays, but that one set is excited most by the larger or red waves, another by the medium or green waves,

and the third set chiefly by the violet or small waves of light; and when all three sets are excited together in proper proportions we see white. This view is supported by the phenomena of color-blindness, which are explicable on the theory that one of these sets of nerve fibres (usually that adapted to perceive red) has lost its sensibility, causing all colors to appear as if the red rays were abstracted from them. It is another property of these various radiations that they are unequally refracted or bent in passing obliquely through transparent bodies, the longer waves being least refracted, the shorter most. Hence it becomes possible to analyze white or any other light into its component rays: a small ray of sunlight, for example, which would produce a round white spot on a wall, if passed through a prism is lengthened out into a band of colored light exactly corresponding to the colors of the rainbow. Any one color can thus be isolated and separately examined, and by means of reflecting mirrors the separate colors can be again compounded in various ways, and the resulting colors observed. This band of colored light is called a *spectrum*, and the instrument by which the *spectra* of various kinds of light are examined is called a *spectroscope*. This branch of the subject has, however, no direct bearing on the mode in which the colors of living things are produced, and it has only been alluded to in order to complete our sketch of the nature of color.

The colors which we perceive in material substances are produced either by the absorption or by the interference of some of the rays which form white light. Pigmental or absorption colors are the most frequent, comprising all the opaque tints of flowers and insects, and all the colors of dyes and pigments. They are caused by rays of certain wave-lengths being absorbed, while the remaining rays are reflected and give rise to the sensation of color. When all the color-producing rays are reflected in due proportion the color of the object is white; when all are absorbed the color is black. If blue rays only are absorbed the resulting color is orange-red; and generally, whatever color an object appears to us, it is because the complementary colors are absorbed by it. The reason why rays of only certain refrangibilities are reflected, and the rest of the incident light absorbed by each substance, is supposed to depend upon the molecular structure of the body. Chemical action almost always implies change of molecular structure; hence chemical action is the most potent cause of change of color. Sometimes simple solution in water effects a marvelous change, as in the case of the well-known aniline dyes, —

the magenta and violet dyes exhibiting, when in the solid form, various shades of golden or bronzy metallic green. Heat, again, often produces change of color, and this without effecting any chemical change. Mr. Ackroyd has recently investigated this subject,[1] and has shown that a large number of bodies are changed by heat, returning to their normal color when cooled, and that this change is almost always in the direction of the less refrangible rays or longer wave-lengths; and he connects the change with molecular expansion caused by heat. As examples may be mentioned mercuric oxide, which is orange-yellow, but which changes to orange, red, and brown, when heated; chromic oxide, which is green, and changes to yellow; cinnabar, which is scarlet, and changes to puce; and metaborate of copper, which is blue, and changes to green and greenish-yellow. The coloring matters of animals are very varied. Copper has been found in the red of the wing of the turaco, and Mr. Sorby has detected no less than seven distinct coloring matters in birds' eggs, several of which are chemically related to those of blood and bile. The same colors are often produced by quite different substances in different groups, as shown by the red of the wings of the burnet moth changing to yellow with muriatic acid, while the red of the red-admiral butterfly undergoes no such change.

These pigmental colors have a different character in animals, according to their position in the integument. Following Dr. Hagen's classification, epidermal colors are those which exist in the external chitinized skin of insects, in the hairs of mammals, and, partially, in the feathers of birds. They are often very deep and rich, and do not fade after death. The hypodermal colors are those which are situated in the inferior soft layer of the skin. These are often of lighter and more vivid tints, and usually fade after death. Many of the reds and yellows of butterflies and birds belong to this class, as well as the intensely vivid hues of the naked skin about the heads of many birds. These colors sometimes exude through the pores, forming an evanescent bloom on the surface.

Interference colors are less frequent in the organic world. They are caused in two ways: either by reflection from the two surfaces of transparent films, as seen in the soap-bubble and in thin films of oil on water; or by fine striæ, which produce colors either by reflected or transmitted light, as seen in mother-of-pearl and in finely-ruled metallic surfaces. In both cases color is produced

[1] Metachromatism, or Color-Change, Chemical News, August, 1876.

by light of one wave-length being neutralized, owing to one set of such waves being caused to be half a wave-length behind the other set, as may be found explained in any treatise on physical optics. The result is that the complementary color of that neutralized is seen; and, as the thickness of the film or the fineness of the striæ undergoes slight changes, almost any color can be produced. This is believed to be the origin of many of the glossy or metallic tints of insects, as well as of those of the feathers of some birds. The iridescent colors of the wings of dragon-flies are caused by the superposition of two or more transparent lamellæ; while the shining blue of the purple-emperor and other butterflies and the intensely metallic colors of humming-birds are probably due to fine striæ.

This outline sketch of the nature of color in the animal world, however imperfect, will at least serve to show us how numerous and varied are the causes which perpetually tend to the production of color in animal tissues. If we consider that, in order to produce white, all the rays which fall upon an object must be reflected in the same proportions as they exist in solar light, whereas, if rays of any one or more kinds are absorbed or neutralized, the resultant reflected light will be colored, and that this color may be infinitely varied according to the proportions in which different rays are reflected or absorbed, we should expect that white would be, as it really is, comparatively rare and exceptional in nature. The same observation will apply to black, which arises from the absorption of all the different rays. Many of the complex substances which exist in animals and plants are subject to changes of color under the influence of light, heat, or chemical change, and we know that chemical changes are continually occurring during the physiological processes of development and growth. We also find that every external character is subject to minute changes, which are generally perceptible to us in closely allied species; and we can therefore have no doubt that the extension and thickness of the transparent lamellæ, and the fineness of the striæ or rugosities of the integuments, must be undergoing constant minute changes; and these changes will very frequently produce changes of color. These considerations render it probable that color is a normal and even necessary result of the complex structure of animals and plants, and that those parts of an organism which are undergoing continual development and adaptation to new conditions, and are also continually subject to the action of light and heat, will be the parts in which changes of

color will most frequently appear. Now, there is little doubt that the external changes of animals and plants in adaptation to the environment are much more numerous than the internal changes, as seen in the varied character of the integuments and appendages of animals (hair, horns, scales, feathers, etc.) and in plants (the leaves, bark, flowers, and fruit), with their various appendages, compared with the comparative uniformity of the texture and composition of their internal tissues; and this accords with the uniformity of the tints of blood, muscle, nerve, and bone, throughout extensive groups, as compared with the great diversity of color of their external organs. It seems a fair conclusion that color *per se* may be considered to be normal, and to need no special accounting for, while the absence of color (that is, either *white* or *black*), or the prevalence of certain colors to the constant exclusion of others, must be traced, like other modifications in the economy of living things, to the needs of the species. Or, looking at it in another aspect, we may say that amid the constant variations of animals and plants color is ever tending to vary and to appear where it is absent, and that natural selection is constantly eliminating such tints as are injurious to the species, or preserving and intensifying such as are useful.

This view is in accordance with the well-known fact of colors which rarely or never appear in the species in a state of nature, continually occurring among domesticated animals and cultivated plants, showing us that the capacity to develop color is ever present, so that almost any required tint can be produced which may, under changed conditions, be useful, in however small a degree.

Let us now see how these principles will enable us to understand and explain the varied phenomena of color in nature, taking them in the order of our functional classification of colors (page 650).

Theory of Protective Colors.—We have seen that obscure or protective tints in their infinitely varied degrees are present in every part of the animal kingdom, whole families or genera being often thus colored. Now, the various brown, earthy, ashy, and other neutral tints are those which would be most readily produced, because they are due to an irregular mixture of many kinds of rays; while pure tints require either rays of one kind only, or definite mixtures in proper proportions of two or more kinds of rays. This is well exemplified by the comparative difficulty of producing definite pure tints by the mixture of two or

more pigments, while a hap-hazard mixture of a number of these will be almost sure to produce browns, olives, or other neutral or dirty colors. An indefinite or irregular absorption of some rays and reflection of others would, therefore, produce obscure tints; while pure and vivid colors would require a perfectly definite absorption of one portion of the colored rays, leaving the remainder to produce the true complementary color. This being the case, we may expect these brown tints to occur when the need of protection is very slight, or even when it does not exist at all, always supposing that bright colors are not in any way useful to the species. But whenever a pure color is protective, as green in tropical forests or white among arctic snows, there is no difficulty in producing it, by natural selection acting on the innumerable slight variations of tint which are ever occurring. Such variations may, as we have seen, be produced in a great variety of ways, either by chemical changes in the secretions or by molecular changes in surface structure, and may be brought about by change of food, by the photographic action of light, or by the normal process of generative variation. Protective colors, therefore, however curious and complex they may be in certain cases, offer no real difficulties.

Theory of Warning Colors.—These differ greatly from the last class, inasmuch as they present us with a variety of brilliant hues, often of the greatest purity, and combined in striking contrasts and conspicuous patterns. Their use depends upon their boldness and visibility, not on the presence of any one color; hence we find among these groups some of the most exquisitely colored objects in nature. Many of the uneatable caterpillars are strikingly beautiful; while the Danaidæ, Heliconidæ, and protected groups of Papilionidæ comprise a series of butterflies of the most brilliant and contrasted colors. The bright colors of many of the sea-anemones and sea-slugs will probably be found to be in this sense protective, serving as a warning of their uneatableness. On our theory none of these colors offer any difficulty. Conspicuousness being useful, every variation tending to brighter and purer colors was selected, the result being the beautiful variety and contrast we find.

But when we come to those groups which gain protection solely by being mistaken for some of these brilliantly colored but uneatable creatures, a difficulty really exists, and to many minds is so great as to be insuperable. It will be well, therefore, to endeavor to explain how the resemblance in question may have

been brought about. The most difficult case, which may be taken as a type of the whole, is that of the genus *Leptalis* (a group of South American butterflies allied to our common white and yellow kinds), many of the larger species of which are still white or yellow, and which are all eatable by birds and other insectivorous creatures. But there are also a number of species of *Leptalis* which are brilliantly red, yellow, and black, and which, band for band and spot for spot, resemble some one of the Danaidæ or Heliconidæ which inhabit the same district, and which are nauseous and uneatable. Now, the common objection is that a slight approach to one of these protected butterflies would be of no use, while a greater sudden variation is not admissible on the theory of gradual change by indefinite slight variations. This objection depends almost wholly on the supposition that when the first steps toward mimicry occurred, the South American Danaidæ were what they are now, while the ancestors of the Leptalides were like the ordinary white or yellow Pieridæ to which they are allied. But the danaioid butterflies of South America are so immensely numerous and so greatly varied, not only in color but in structure, that we may be sure they are of vast antiquity and have undergone great modification. A large number of them, however, are still of comparatively plain colors, often rendered extremely elegant by the delicate transparency of the wing membrane, but otherwise not at all conspicuous. Many have only dusky or purplish bands or spots, others have patches of reddish or yellowish brown, — perhaps the commonest color among butterflies, —while a considerable number are tinged or spotted with yellow, also a very common color, and one especially characteristic of the Pieridæ, the family to which *Leptalis* belongs. We may therefore reasonably suppose that in the early stages of the development of the Danaidæ, when they first began to acquire those nauseous secretions which are now their protection, their colors were somewhat plain, either dusky with paler bands and spots, or yellowish with dark borders, and sometimes with reddish bands or spots. At this time they had probably shorter wings and a more rapid flight, just like the other unprotected families of butterflies. But as soon as they became decidedly unpalatable to any of their enemies, it would be an advantage to them to be readily distinguished from all the eatable kinds; and as butterflies were no doubt already very varied in color, while all probably had wings adapted for pretty rapid or jerking flight, the best distinction might have been found in outline and habits;

whence would arise the preservation of those varieties whose longer wings, bodies, and antennæ, and slower flight, rendered them noticeable,—characters which now distinguish the whole group in every part of the world. Now, it would be at this stage that some of the weaker-flying Pieridæ which happened to resemble some of the Danaidæ around them in their yellow and dusky tints, and in the general outline of their wings, would be sometimes mistaken for them by the common enemy, and would thus gain an advantage in the struggle for existence. Admitting this one step to be made, and all the rest must inevitably follow from simple variation and survival of the fittest. So soon as the nauseous butterfly varied in form or color to such an extent that the corresponding eatable butterfly no longer closely resembled it, the latter would be exposed to attacks, and only those variations would be preserved which kept up the resemblance. At the same time we may well suppose the enemies to become more acute and able to detect smaller differences than at first. This would lead to the destruction of all adverse variations, and thus keep up in continually increasing complexity the outward mimicry which now so amazes us. During the long ages in which this process has been going on, many a *Leptalis* may have become extinct from not varying sufficiently in the right direction and at the right time to keep up a protective resemblance to its neighbor; and this will accord with the comparatively small number of cases of true mimicry as compared with the frequency of those protective resemblances to vegetable or inorganic objects whose forms are less definite and colors less changeable. About a dozen other genera of butterflies and moths mimic the Danaidæ in various parts of the world, and exactly the same explanation will apply to all of them. They represent those species of each group which, at the time when the Danaidæ first acquired their protective secretions, happened outwardly to resemble some of them, and have by concurrent variation, aided by a rigid selection, been able to keep up that resemblance to the present day.[1]

(To be concluded.)

[1] For fuller information on this subject the reader should consult Mr. Bates's original paper, Contributions to an Insect-Fauna of the Amazon Valley, in Transactions of the Linnean Society, vol. xxiii., p. 495; Mr. Trimen's paper in vol. xxvi., p. 497; the author's essay on Mimicry, etc., already referred to; and, in the absence of collections of butterflies, the plates of Heliconidæ and Leptalidæ, in Hewitson's Exotic Butterflies, and Felder's Voyage of the Novara may be examined.

THE ROCKY MOUNTAIN LOCUST.[1]

BY C. V. RILEY, PH. D.

THE subject which you have assigned to me is entitled The Rocky Mountain Locust and the Army Worm. Both these insects are extremely injurious to the agriculture of the United States, and as it would be difficult to do justice to both in the compass of a brief address I shall confine my remarks at the present time to the first named. So much has been written and said, by myself and others, upon this Rocky Mountain locust during the past two or three years that it would seem difficult indeed to say anything about it that is new or of value. Yet I may safely assert that most of the definite and accurate knowledge regarding its habits and life history was first given to the world during the present year.

Though popularly known as the "grasshopper," yet the term "Rocky Mountain locust," proposed by myself, has been very generally adopted as most appropriate. The insect belongs to the same family as the locusts of Scripture. The term grasshopper is very loosely applied to many insects that hop about in grass, but strictly belongs to the long-legged, long-feelered species. Locusts have short and stout legs, short and stout feelers, and are mute, or, if they stridulate at all, do so by rubbing the hind thighs against the sides of the folded front wings; their prevailing color is brown; they are gregarious, and they oviposit in the ground by means of short, drilling valves. True grasshoppers have long and slender legs and feelers, and stridulate by vibrating the front wings, which in the males are furnished, generally near the base, with talc-like plates crossed by enlarged and hollow veins; their prevailing color is green; they are solitary, and they mostly oviposit in different parts of plants, by means either of a sword- or scimeter-shaped ovipositor. It is the grasshoppers, the katydids (which are a tree-inhabiting section of them), and the crickets which make field and wood resound with shrill orchestry at the present season; but the locusts take no part in the concert. While our insect belongs, therefore, to the same family as the locusts of Scripture, those people are greatly at sea who imagine it to be specifically identical with any of the Asiatic or European species. It is known to entomologists as

[1] An address delivered at the Chicago session of the American Agricultural Congress, in September, 1877. Some portions are omitted for want of space. — ED.

Caloptenus spretus, and is purely American, since it does not inhabit any other continent.

Evolutionists believe — and I am one of them — that existing species are but the modified descendants of preëxisting species. The present species of a genus have at some time, more or less remote, had a common ancestry. All life exhibits a certain power of adaptation to surrounding conditions, and through what is known as "natural selection" (two words which by Darwin's pregnant pen have come to express volumes of facts and consequences), coupled with other less easily formularized laws, the fauna and flora of the globe have been as profoundly changed as have its physical conditions. The influences that have thus worked in the past are still working at present — less rapidly, perhaps, in the main, but none the less effectually. Among higher and more complex animals the changes are slow and not very noticeable; the species have become, in most cases, markedly differentiated, and their characters are well fixed. Among lower organisms these changes are more obvious, and naturalists are sorely puzzled in their endeavors to grasp and express them. This is especially the case among insects. We have the simple variation from the typical characters of a species; we have phytophagic varieties, or those departures from the type that result from the kind of food assimilated during growth; we have phytophagic species, or those variations which have become fixed and permanent in the adolescent or immature stages through some peculiar and fixed habit, without having yet modified the imago or mature state; we have geographical variation, increasing — usually with distance — until the separation from the type is sufficient to be indicated by what we call race; we have seasonal variation, sexual variation, and, finally, we have the terms dimorphism, heteromorphism, and many other *isms*, to express still other variations. In short, in the strain, the breed, the sport, the tribe (in the popular sense), the variety, and the race, we have so many terms invented to indicate some of the more patent steps in the evolution of one species from another, and between them all there are so many shades of variation for which no words have yet been coined, that the naturalist who takes a comprehensive view of life upon our planet finds that what we have chosen to call *species* are often with difficulty separated from each other; that they have, in fact, no real existence in nature. All our classificatory divisions are more or less conventional. They are excellent as aids to thought and study, but misleading when be-

lieved — as they popularly are — to express absolute creations that have existed for all time.

As with other species, so it is with the locust under consideration. The species is a denizen of the plains regions of the Rocky Mountains to the west and northwest of us. It breeds continuously and comes to perfection only in those high and dry plains and prairies; and though at intervals it overruns much of the lower, moister country to the east and southeast, yet it never extends in a general way to the Mississippi. But there are species east of the Mississippi that are so closely allied to it that the ordinary farmer cannot, without a little special knowledge, appreciate the difference, and entomologists, even, are not of a mind as to whether they should be called species, varieties, or races, etc. The two species most closely allied to the Rocky Mountain locust are the red-legged locust (*Caloptenus femur-rubrum*) and the Atlantic locust (*Caloptenus Atlantis*). Both are wide-spread species, but are either rare or do not occur in the home of *spretus*. The differences between the three species I have elsewhere given in detail; for the present purpose it suffices to say that the distinguishing characters, most easily observed by the non-entomologist, are the relative length of the wing and the structure of the terminal joint of the male abdomen. The Rocky Mountain species has the wings extending, when closed, about one third their length beyond the tip of the abdomen, and the last or upturned joint of the abdomen narrowing like the prow of a canoe, and notched or produced into two tubercles at top. The wings of the red-legged locust extend, on an average, about one sixth their length beyond the tip of the abdomen, and the last abdominal joint is shorter, broader, more squarely cut off at top, without terminal tubercles, and looks more like the stern of a barge.

The Atlantic locust, though smaller than either, is in other respects intermediate between the two, but in relative length of wing and structure of the anal joint in the male, most related to *spretus*.

We should encourage the locust's natural enemies. Practically this is not possible with many of the smaller parasitic and predaceous kinds; they are beyond our control. With many of the larger locust enemies, however, as in the case of birds, it is feasible. One of the most effectual ways of accomplishing it is to offer a reward for hawk-heads, as Colorado has done. The introduction of such hardy locust-feeding birds as the grackle and the

English rook may be attended with benefit, and the commission of which I am a member will try the experiment. The destruction of the eggs is of the utmost importance.

The experience of the present year has proved, what I have always insisted on, that in the more thickly-settled portions of the country, by proper organization and intelligent effort, man may master the young insects. Men of large experience admit that a crop of young locusts is not more difficult to cope with than a crop of weeds. It is different with the winged insect, and the question is: "Can anything be done to protect our farmers from the disastrous flying swarms?" At first view it would seem hopeless. Yet there is already a partial answer to the question. There is a popular notion that this pest breeds in and comes from sandy, desert countries. It is a popular error. The insect cannot live on sand, nor does it willingly oviposit in a loose, sandy soil. It does not thrive on cacti and sage-bush. It flourishes most on land clothed with grass, in which, when young, it can huddle and shelter. It can multiply prodigiously on those plains only that offer a tolerably rich vegetation, — not rank and humid as in Illinois, but short and dry, — such as is found over much of the plains region of the Northwest, already referred to. Now the destruction of the eggs, which is so practicable and effectual in settled and cultivated sections, is out of the question in those vast unsettled prairies; but the destruction of the young locusts is possible. Those immense prairies are not only susceptible of easy burning, but it is difficult to prevent the fire from sweeping over them. Now some system of preventing the extensive prairie fires that are common in that country in fall, and then subsequently firing the prairie in the spring, after the bulk of the young hatch, and before the new grass gets too rank, would be of untold value if it could be adopted. At first blush such a proposition seems utopian, but the more I study the question, and the more I learn of those breeding-grounds, the more feasible the plan grows in my mind. The Dominion government has, fortunately, a well-organized mounted police force which constantly patrols through the very regions where the insects breed, north of our line. This force is intended to see that the peace is kept, to watch the Indians, to enforce the laws, and perform other police duties. It could be utilized, without impairing its efficiency as a police force, in the work I have indicated; or it might be augmented for that same work. I have conversed with the Canadian ministers of agriculture and of the interior, and

with Governor Morris, on the subject, and they see nothing impracticable in the plan. We have on this side the line a number of signal stations and military posts in the country where the insect breeds. Now, I would have our own military force coöperate with the Dominion police force as a locust vigilance committee. Under the intelligent guidance and direction of some special commissioner or commission, I would have that whole country systematically studied every year by such a force, with reference to the abundance or scarcity of the locusts. I would have such a vigilance force, by a proper system of fire-guards and surveillance, prevent the fall fires in sections where the insects or their eggs were known to abound, in order to burn them at the proper time the following spring; and where such precaution was not possible or had failed, and the winged insects at any season were numerous, I would have their movements carefully watched, and communicated daily to the signal officers, to be by them communicated to the farmers. In this way the latter could be fully forewarned of approaching danger. I would have the Western farmers adopt some general plan of defense against possible invasion. The straw that is now allowed to rot in sightless masses as it comes from the thrasher, and that encumbers the ground unless burned, should be utilized. Let it be stacked in small pyramids at every field corner, and there let it remain until the locusts are descending upon the country. Then let the farmers in a township or a county, or in larger areas, simultaneously fire these pyramids, using whatever else is at hand to slacken combustion and increase the smoke, and the combined fumigation would partially or entirely drive the insects away, according as the swarm was extended or not. In short, not to weary you, I believe, first, that by proper coöperation on the part of the two governments interested, the excessive multiplication of this destructive insect may be measurably prevented in its natural breeding-grounds, and that the few thousand dollars that would be necessary to put into operation intelligent coöperative plans were most trifling in view of the vast interests at stake. In fact, with an efficient and properly organized department of agriculture, liberally supported by Congress, and aided by the war department and the signal bureau, the plan could soon be perfected and carried out at minimum expense. I believe, secondly, that where the insect's multiplication cannot be prevented in its natural breeding-grounds our farmers in the more thickly-settled sections may, by the use of smoke, measurably turn the course of invading swarms and

protect their crops, — obliging the insects to resort to the uncultivated areas.

Were the injury to continue for another three or four years as it has for the past four, and were the Western farmers to suffer a few more annual losses of forty million dollars, such schemes as I have suggested would soon be carried out. The danger is that during periods of immunity, indifference and forgetfulness intervene until another sweeping disaster takes us by surprise.

Rules greatly assist in the solution of any problem, and in proportion as we get at a knowledge of the laws governing this Rocky Mountain locust shall we be able to overcome it. The country which it devastates is so vast, and the question as to its origin and the causes of its disastrous migrations is so complicated, that a limited study is apt to beget doubt as to whether there are any laws governing the insect or any rules for our guidance. The facts of sociology are so innumerable that the ordinary gleaner of them reaps but confusion. It requires the genius and comprehensiveness of a Herbert Spencer to deduce principles therefrom, — to perceive the laws by which society is molded. The vain, delusive confidence begot of first study of any difficult subject — that follows superficial knowledge, — reacts in doubt and diffidence upon deeper delving and more thorough study.

"The more I learn the less I know" is a paradoxical but very common remark. It is only after passing through this period of doubt in any inquiry that we can begin to see the light; and in this locust inquiry it is only after accumulating facts and experiences until they almost overwhelm us with their complexity that we can begin to generalize and deduce rules.

The history of this insect east of the Rocky Mountains, when viewed from a comprehensive stand-point, presents certain well-marked features. We have, first, the migrations of winged swarms in autumn from the higher plains of the West and Northwest, into the more fertile country south of the 44th parallel and east of the 100th meridian. It is the more fertile and thickly-settled country south and east of the limits indicated which suffers most, both from the insects which sweep over it and from the young that hatch in its rich soil; and it is principally this country which I have designated as being outside the insect's native home, and in which it can never become a permanent resident. The species does not dwell permanently even in much of the country north and west of those lines, but it flour-

ishes more and more toward the northwest. In short, the vast hot and dry plains and prairies of Wyoming, Dakota, and Montana, and the immense regions of a similar character in British America, comprising what is known as the third prairie plateau or steppe, are congenial breeding-grounds, and supply the more disastrous swarms which devastate the lower Missouri and the Mississippi valleys. That northwest country may be depicted as a vast undulating prairie sea, now stretching in sandy barren tracts which bring forth little else than the cactus or sage-bush; now rolling for hundreds of miles, and covered with the buffalo grass (*Bucloe dactyloides*) and other short nutritious grasses, and again producing a ranker prairie growth wherever there is increase of moisture. Another peculiarity of that country is that though the spring opens as early, even away up in the valley of the South Saskatchewan, as it does in Chicago, yet the vegetation often becomes parched up and burned out by the early part of July. Now, *Caloptenus spretus*, though coming to perfection in high and dry regions, is nevertheless fond of succulent vegetation, and instinctively seeks fresh pastures whenever those of its own home are dried up. It may sometimes happen, indeed, that the species will die in immense numbers if the scant vegetation where it breeds should dry up before the acquisition of wings, just as another species (*Œdipoda atrox*) has perished in immense numbers the present season in California by the excessive drought that has prevailed there; but ordinarily the insects will be full grown and fledged before the parched season arrives, and the ample wings of the species prove its salvation. Again, it may become so prodigiously multiplied during certain seasons that everything green is devoured by the time its wings are acquired.

"In either case, prompted by that most exigent law of hunger, — spurred on for very life, — it rises in immense clouds in the air to seek for fresh pastures where it may stay its ravenous appetite. Borne along by the prevailing winds that sweep over these immense treeless plains from the northwest, often at the rate of fifty or sixty miles an hour, the darkening locust clouds are soon carried into the moist and fertile country to the southeast, where with sharpened appetites they fall upon the crops, a plague and a blight. Many of the more feeble or of the more recently fledged perish, no doubt, on the way; but the main army succeeds, with favorable wind, in bridging over the parched country which affords no nourishment. The hotter and dryer the season, and the greater the extent of the drought, the earlier

will they be prompted to migrate, and the farther will they push on to the east and south."[1]

We have, second, the return migration toward the northwest from the country south and east of the lines already indicated, of the progeny of invading swarms, as soon as wings are acquired the next summer. Time will not permit me to present the explanation of this return migration. In the work just quoted I have discussed its causes, the reasons why the species cannot permanently thrive in the Mississippi valley, and the conditions which prevent its establishment there.

We have, third, the eastern limit of the insects' spread along a line broadly indicated by the 94th meridian, and the consequent security from serious injury east of that line.

These three features of our disastrous swarms — the return migration from the southeast country (which implies only temporary injury therein), and the eastern limit, — may be stated as laws governing the insect east of the Rocky Mountains. They have constantly been urged by me, and the present year's experience has confirmed and verified them. I think I may safely present a fourth, namely, that the eggs are never laid thickly two successive years in the same regions.

In mapping out the country in Kansas and Missouri in which eggs had been laid most thickly in 1876, I was struck with the fact that the very counties in which the young insects had been most numerous and disastrous in 1875 were passed by or avoided, and had no eggs of any consequence laid in them in 1876. The fact was all the more obvious because the insects did much damage to fall wheat, and laid eggs all around those counties, to the north and south and west. From the exhaustive report on the insect in Minnesota, made by Mr. Allen Whitman, it was also very obvious that those portions of that State which had been most thickly supplied with eggs in 1875, and most injured by the young insects in 1876, were the freest from eggs laid by the late swarms of the latter year, notwithstanding counties all around them were thickly supplied. I was at first inclined to look upon these facts as singular coincidences only; but instances have multiplied. A remarkable one has been furnished me by Gov. A. Morris, of the northwest territory. You are well aware that in 1875 the locusts hatched out in immense numbers and utterly destroyed the crops in the province of Manitoba. Now, in 1876 they were very numerous over all the third prairie

[1] Locust or Grasshopper Plague, page 57. Rand, McNally, & Co., Chicago.

steppe of British America, and largely went to make up the autumn swarms that came into our own country a year ago. Governor Morris started late in July of 1876 from Winnipeg northwest to make a treaty with certain Indians, and during the first five or six days of August he encountered innumerable locust swarms all the way from the forks of the two main trails to Fort Ellice. The wind was blowing strong from the west all the time, — just the very direction to carry the insects straight over into Manitoba. The governor watched their movements with the greatest anxiety, fearing that the province would again be devastated as it had been the previous year. Yet during all the time he was passing through the immense swarms, they bore doggedly to the south and southeast, either tacking against the wind or keeping to the ground when unable to do so. Nothing was more remarkable than the manner in which they persisted in refusing to be carried into Manitoba. A few were blown over, but did not alight, and the province seemed miraculously delivered. Mr. Whitman tells me, again, that in settling the present year the insects avoided those counties in Minnesota in which they had hatched most numerously and done greatest injury, but selected such as had not suffered for some years past.

It is evident that there is more than mere coincidence in these occurrences, and I may say that upon looking more deeply into the matter I cannot find a single instance where eggs have been laid thickly for two successive years in any invaded country. This is a most important fact. During a season of great devastation there is a natural tendency among the more pious portion of the community to beseech the Almighty, by prayer, fasting, and humiliation, for deliverance. How greatly their faith must be strengthened by facts such as I have just stated! As a naturalist it is my province to study the reasons for the facts. Whether what I call the working of natural laws be called by others the instrumentality of Providence is quite immaterial.

To recapitulate, I think we may safely deduce the following four rules as governing the Rocky Mountain locust east of the mountains from which it takes its name: —

(1.) The northwest origin of the more disastrous fall swarms that overrun the more fertile country south of the 44th parallel and east of the 100th meridian.

(2.) The return migration toward the northwest of the insects that hatch in the country named.

(3.) The eastern limit of the insects' spread along the 94th meridian.

(4.) No two successive hatchings of an extensive and disastrous nature can take place in the same region.

The possibility of exception to the rules would be in keeping with the character of all rules; but I am convinced that the exceptions will ever prove most trifling. Now there is a deal of satisfaction to be drawn by our farmers from these rules, which not only limit locust disaster but enable them to anticipate events; and I need hardly state that the accuracy of my own prognostications, repeatedly made during the past three or four years, was in no small degree due to them.

We have had the spectacle of the Rocky Mountain locust, in what I call the return migration, flying over some parts of the vast territory from the 29th parallel to the Dominion boundary line, and from the 94th meridian to the mountains, all along from the end of April till the beginning of August, and with so little injury that, with the exception of the case in Montana, just mentioned,[1] the question everywhere asked is, Where have the flying 'hoppers gone? What has become of them? I answer that, as in previous years, and as I have always held would be the case, they were, in the main, so diseased and parasitized that they dropped in scattered numbers and mostly perished on their northward and northwestward journey. This is no theory, but known to have been the case in the more thickly-settled parts of Kansas, Nebraska, Iowa, and Minnesota, from which the insects that had dropped have been reported, and in some cases sent to me. But as the flight is for the most part over the vast and thinly-settled plains of Indian Territory, Kansas, Nebraska, and Colorado, the number that has dropped and been lost to sight in said plains is infinitely greater than that which has been observed to come down in the more thickly-settled regions to the east.

The more dense and extensive swarms that flew before the 1st of July reached, I have little doubt, the great thinly-settled plains and prairie region of Northwest Minnesota, Dakota, Montana, and British America, — embracing in the latter case most of the country between the projected line of the Canada Pacific and the boundary line, and between Manitoba and the Rocky Mountains. I found the insects sparsely spread over the rank prairies west of Brainerd along the Northern Pacific and along Red River; and by this I mean that a few would hop from the grass at every step, wherever I searched for them. I met with only here and there a straggler in Manitoba; but early in July

[1] Referred to in the portions omitted. — Ed.

they flew from the south over the country west of the province, and reached the North Saskatchewan at several points, passing many miles north of Fort Carleton.

The insects that rose after the first week in July (mostly from restricted parts of Minnesota and Dakota) bore for the most part southwardly, while many of those which passed to the northwest earlier in the season returned. Thus, swarms more or less scattering have been passing for the past two months over parts of Iowa, Nebraska, and Kansas, in varying directions, but mainly to the south and southeast. They have lately reached into the Indian Territory. In no instance have they done serious damage, and the reports that come to me are singularly unanimous on this point. The movements of the insects that bred in Minnesota this year were very similar to the movements of those that bred there in 1876. They at first flew to the northwest, but were subsequently brought back, and traveled over parts of Iowa, Nebraska, and Kansas. The difference between the two years is that the flights that thus turned back on the original course in 1876 were recruited and followed by immense and fresh swarms from the northwest plains regions, where, far beyond the boundary line, they hatched and bred innumerably; whereas the Minnesota swarms of 1877 have not been recruited because there were few eggs laid in 1876, and no insects of any consequence reared in 1877 in said northwest country. It is upon this fact that I have founded the belief in no serious devastation in the southeast country this fall.

To those who pay little attention to the subject the disappearance of the swarms that left the Mississippi Valley is matter for wonder. "What is hit is history, but what is missed is mystery." Who, at the explanation of some simple trick or piece of legerdemain, has not smiled to think how easily he was baffled? But there are those who prefer the mystery of ignorance, and would much rather believe that the locusts have vanished in the heavens or been swept into the ocean than accept any explanation; and there are others who, from sectional feelings, would much rather believe that the insects have flown to Canada and New England than accept the facts.

GLACIAL MARKS ON THE PACIFIC AND ATLANTIC COASTS COMPARED.

BY A. S. PACKARD, JR.

WHILE in Europe one can readily interpret the ancient moraines and other ice marks by reference to existing glaciers with their moraines, ice grooves, and scratches, the American geologist is usually forced to make a long journey to Switzerland, the Pyrenees, or to Norway in order to observe such phenomena, now to be seen on an extended scale only in Arctic America and in Greenland. However, the recent discovery by Mr. Clarence King of a few small glaciers in the Sierra Nevada of California has, with the observations of others, shown, what was quite unsuspected a few years ago, that not only the Rocky Mountains but the Sierra Nevada have been the seat of extensive glaciers, which in the Sierra Nevada descended to a point between two and three thousand feet above the sea, or as low as five or six thousand feet in the Rocky Mountains. We had followed up these discoveries with much interest, and made during our entomological journeys cursory observations upon ancient glaciers and rounded rocks in the Rocky Mountains in 1875, and again during the early part of the past summer in Montana and parts of adjoining Territories. In the course, however, of an extended journey through Middle and Northern California, portions of Oregon, Washington Territory, and Vancouver Island, undertaken in the interests of the United States Entomological Commission, I was enabled from the stage-coach, or on horseback, or in the course of my entomological walks, to observe certain more salient points, which some experience in past years in the study of surface geology in Switzerland and Norway, as well as in New England and Labrador, rendered of a comparative nature and proved of great personal interest. Indeed, I have been struck with the remarkable parallelism between all the more general glacial phenomena, whether observed in the Old or on the Atlantic or Pacific borders of the New World.

A rapid and too cursory inspection of the Whitney Glacier on Mount Shasta, of the moraines upon its lower extremity and of the ancient ones on the flanks of the mountain, which have been in part described by Mr. King, though much still remains to be studied, has enabled us, as never before, to comprehend the

peculiar features in the system of ancient modified moraines of Central and especially Southern New England, including Nantucket, Martha's Vineyard, and the Elizabeth Islands. It seems to us plain enough that the ridges, or osars, and tumuli of gravel, as well as the sudden depressions among them, so frequent in New England, particularly about Salem and Andover, Mass., and in Maine, are of direct glacial origin.

The ascent of the crater cone of Mount Shasta was made during a short stay at Sisson's Station, at the base and to the southwest of the mountain, under the guidance of Mr. J. H. Sisson, who as the former guide of Mr. King and others was familiar with the moraines and glaciers of this magnificent peak. Never had I seen such a pure mountain form, chiseled out by the subterranean forces. No mountain, so far as we know, in Europe or America north of Mexico approaches it in its treble qualities of isolation, its regular conical form, and great altitude. Its summit for about four thousand feet is in large part covered with snow fields, and three glaciers, the Whitney, McCloud (on the eastern side), and Ash Creek (on the northeast), descend its flanks to or near the timber line, which is at an elevation of about nine thousand feet. I afterwards, in Oregon, had distant views of Mounts Hood, Adams, and St. Helens, members of the same family of extinct volcanoes, which form snow-capped, isolated cones rising about eight or nine thousand feet above the Cascade Range, which seemed dwarfed by their presence. I ascended the crater cone of Shasta by the trail leading from Sisson's hotel, and descended the eastern side to a point immediately overlooking the Whitney Glacier, which is about three miles long and extends from the summit of Shasta Peak down to or quite near the line of trees. With a good glass I could study the surface of the glacier for its whole length. The following account of the moraines and glacial marks is taken nearly as I wrote it down on the spot: —

August 25th we camped at the foot of the crater cone, and after a clear, cold night, the ice forming nearly an inch thick, we made an early start and reached the summit of the crater before nine o'clock. Here a magnificent view was spread out at our feet.

To the northwest lay the Siskiyou Range and Pilate's Knob, to the west the serrated range of the Salmon Mountains, while to the south rose to the altitude of about twelve thousand feet Lassen's Peak, its snow-clad summit glistening in the sun. The eye

also ranged northeasterly over the lava plains, where the Modoc war formerly raged, and over the Klamath Lakes and Tule Lake. At our feet yawned the crater, about a thousand feet deep, its rim guarded by sharp, jagged pinnacles, while immense snow fields ran down to the bottom, in which lay two small frozen lakes.

On reaching our point of view overlooking the glacier, Mr. Sisson, who though he has observed the glacier for many years, had not now seen it for four years, remarked that it had diminished very considerably, the surface appearing at least seventy-five or one hundred feet lower than when he saw it four years previous. The glacier lies in a gulch on the north side of the mountain, and heads in a field of snow, or *névé*, which Mr. Sisson told me was continuous with the McCloud Glacier. The upper end must be over 13,500 feet in elevation. The surface is white and clean near the top. Ice cascades and crevasses begin very near the upper termination. On the upper portion on the east side, under a perpendicular wall of rock, is a lateral moraine, and a little farther down, where the glacier abuts against the crater cone, is a lateral moraine on the west side. The eastern lateral moraine ends in three ridges of dirt and loose masses of rock, and the terminal moraine covers the bottom of the glacier and connects the two lateral moraines. The end of the glacier, instead of being free of detritus, pushing the mass before it as in most European glaciers, runs under the terminal moraine for a considerable distance, the ice here and there projecting above the surface of the moraine. When these should melt away hollows would be formed, like those seen in the ancient moraines about Salem, Mass., and Southern New England. Large, angular bowlders lie scattered over the lower part of the glacier. The glacier extends nearly to the timber line, and seemed by a rough guess to be about three miles long. At the middle of the glacier the walls of lava rock are but slightly worn by the ice, owing to the hardness of the rock, and no grooves were to be seen. The glacier, judging by the frequent explosions, was in motion.

At and beyond the end of the present terminal moraine lies the former extension of it, constituting naked plains ; and below, the still more ancient moraine, showing the former size of the glacier, and comprised of a series of well-wooded hills. A muddy stream with a white bed and banks runs north into Shasta Valley from the end of the glacier. Near the termination of the glacier on the northeast side are three well-marked old naked moraines, at least

two miles long, sweeping around to a small extinct volcano perhaps one thousand feet in height, ending in nine or ten small cones. These moraines apparently connect with the terminal moraine of a small, narrow glacier just east of Whitney's, and which must formerly have made an upper eastern branch of it. As evidence of the former extension of the glacier down into the Shasta Valley are two well-rounded hills, evidently regularly moulded by ice, and forming flattened domes.

The trail from the cone to Sisson's house lies over a lava ridge, formed of loose, angular bowlders of the reddish lava composing the cones, with a few bowlders of a whitish rock. For several miles it was arranged in transverse terraces or benches a few feet in height, with rock masses piled upon them in slightly concentric parallel transverse rows, the interspaces being clear of rocks. It extends about eight miles from the base of the cone down into the forest, and is so irregular, rough, naked, and jagged that Mr. Sisson has well christened it the "Devil's Garden." At first it seemed to me to be simply an old lava stream, like those I had seen on Mount Vesuvius; but after riding several hours over and past it, both on my way to and from the cone, and noticing the foreign bowlders on its surface, and two lateral moraines on the sides, it seemed without doubt to be a long, narrow, median moraine. For the greater portion of its length the sides are remarkably steep and regular, and it has a remarkable external resemblance to the gravel ridges in Andover, Mass., and other portions of New England.

To the southward, between the cone and the main peak, is a small park in which a glacier must formerly have rested; on the outer western edge is a small terminal moraine, flanked by a lateral moraine on each side.

As the crater cone is composed of a light reddish lava, while the much older main peak consists of a pale, bluish-gray trachyte, it is easy to distinguish the respective origins of the long lateral moraines which extend from the two peaks, the last red lava ridges extending down from the crater cone, lying parallel to the northwesternmost pale gray moraine of the main peak. The trachyte moraines even extend ten or twelve miles down to the west side of the stage road a little north of Sisson's hotel, where there are several conical hills of *débris*, which had evidently come from the main peak of Mount Shasta.

The fact of most interest connected with the Whitney Glacier is that the ice is concealed for a considerable distance by the ter-

minal moraine, and that by the melting of the ice the hillocks would not only remain, but deep hollows would be left. Now we have precisely the same contour of the surface over a large part of Essex County, Mass., particularly about Salem and on the islands on the southern shore of New England. The peculiar scenery about Salem and Andover, and on Naushon Island, Martha's Vineyard, etc., can be fully explained by a reference to the terminal moraines on the glaciers of Mount Shasta, as in fact has been done by Mr. King.[1] Again, I believe the so-called *kames*, *osars* or *eskers* of New England, such as Indian Ridge in Andover, Mass., and similar horsebacks in the White Mountains and in Maine, which I have examined, are much like the long, slender ridges of gravel and bowlders which lie on the flanks of Mount Shasta. Without much doubt the bulk of the glacial drift of the Northern Atlantic States was ground-moraine material, while a large proportion formerly covered the ice sheets, often thin and broad, which spread out over the hilly portions of the country; and the gravel ridges or eskers were lateral moraines, though perhaps also in part terminal, which have been partly rewashed by fresh or salt water.

Very interesting moraines were again seen on both sides of the stage road in Butteville, Shasta Valley. A remarkable one, evidently derived from the crater cone, and which must be ten or fifteen miles in length, is composed of small bowlders of reddish lava, arranged in transverse rows, with clear interspaces, the ridges not being more than a foot or two high, the bowlders being much smaller and less angular, having traveled farther than those in the Devil's Garden.

The glacial phenomena about Puget Sound and the southern extremity of Vancouver Island, about Victoria, were of a high degree of interest. Leaving the Columbia River at Kalama the Northern Pacific runs through a broad, park-like valley covered originally with pine forests, the valley widening towards Tacoma, at the head of Puget Sound, the surface being flat or undulating, with quite well-marked moraine hills and gravelly ridges, resembling those in New England. This region, like the New England coast, has been under the sea, and the waters of Puget Sound have washed and rewashed the original moraines, so that the scenic features are strikingly similar to the familiar plains and fields and ridges about Boston and Salem, as well as Southern

[1] Mountaineering in the Sierra Nevada, 1872; and Some Remarkable Gravel Ridges in the Merrimac Valley, by Rev. G. F. Wright, 1877.

Maine. Here, evidently, the moraines had come down on glaciers from the Cascade Range, the source mainly perhaps from Mount Rainier, now a lofty, snow-clad cone like Mount Hood.

The former glaciers about Puget Sound were apparently a part of the series now existing in Alaska and described by Mr. W. H. Dall. Along the railroad track, within eight or ten miles of Tacoma, was a series of twelve or fifteen low, gravel ridges as level and with as regular a slope as fortifications. They run north by east and south by west, in a course generally parallel with the Cascade Range. I could not but compare them with the series of transverse ridges on the Mount Shasta moraines, and regard them as marking the steps in the retreat of a broad, thin mass of ice extending into one of the arms of Puget Sound from the neighborhood of Mount Rainier.

The shores of Puget Sound from Tacoma to Port Townsend are lined with a series of sands and gravels capping marine clays, in all respects like the cliffs of Massachusetts Bay and the Maine coast; and indeed the scenic features of Puget Sound with its many long, narrow reaches recall the lakes of Maine and Southern Norway. But at Vancouver Island, the resemblance is still more striking. Here the rocks in several localities about Victoria, on the shores of the Straits of Fuca, are as deeply furrowed and scored as I have seen anywhere on the coast of New England or of Norway. The trap and syenite down to the water's edge are smoothed and polished, with often deep furrows several inches wide, all running north 10° west, and south 10° east. The glacier which made them must have come from the centre of Vancouver Island, which is high and mountainous. Particularly interesting was the presence of fossil quaternary shells in the clay which covered the rocks, and which in color and scenic features exactly reproduced that formation, so familiar to me on the coast of Maine.

The clays were fine, stratified, though perhaps less so than Atlantic coast clays, with bowlders, mostly angular, but some well scratched and glacier-worn. These beds graduated above into regularly stratified pebbly, or gravelly, or sandy beds capped by black mold containing Indian shell heaps. The fossil shells and barnacles occurred from two to ten feet above the sea level. The species obtained were submitted to Mr. R. E. C. Stearns of the University of California, who kindly named them for me. They are enumerated in accordance with their relative abundance, the *Cardium corbis* being by far the most common.

Cardium corbis Martyn. Now a common Pacific coast shell.
Schizothærus Nuttalli Conrad, " " " "
Purpura crispata Chemnitz, " " " "
Mytilus modiolus Linn., " " " "
Leda fossa Baird. One perfect example.

The valves of an enormous barnacle (probably *Balanus tintinnabulum*) frequently occurred. It lives abundantly on the rocks about Victoria.

Glacial phenomena of quite a different nature were observed in the Yosemite Valley. From a hasty examination of the valley and its surroundings from Glacier Point, as well as different localities in the valley itself, it seemed plain enough that the valley, originally due to a series of faults as described by Professor Whitney and Mr. King, had become filled with ice continuously with the upper valley, as high up at least as the summit of Mount Starr King, which is a rounded dome; the source of the supply being the high peaks of the Sierra, such as Mounts Dana and Lyell, which are jagged and not molded by ice, all the peaks below having been rounded and worn by ice, while the sides of the valley in the more exposed places, and the North Dome and Half Dome, have been, as described by Mr. John Muir, molded and smoothed by the ice. The walls of the outlet, or lower valley, seemed also to have been molded by ice.

The history of the valley appeared to us somewhat in this wise: After its present shape had been marked out, and the mountains round about had assumed their present shape, the result of atmospheric erosion during the later tertiary period, the climate changed, the Sierra was covered with glaciers, and the Yosemite Valley was filled to overflowing with ice. It melted, and filled the bottom of the valley, which now forms a level park. The small, low, terminal moraine at the lower end of the valley, which formerly dammed the Merced, was finally cut through by the river and the park drained, and the present aspect of this wonderful cañon succeeded. This is the history of many valleys which I have seen in New England, Labrador, and Scandinavia, and the parallelism between them seems remarkably exact.

RECENT LITERATURE.

BOBRETZKY'S RESEARCHES ON THE DEVELOPMENT OF CEPHALOPODA.[1] — This is an elaborate work on the development of the cuttle-fishes belonging to the genera Loligo and Sepia. It is based on thin sections of the eggs, and has every appearance, from the plates, of being a critical and exhaustive treatise. Although the text is in Russian, an explanation of the plates is given in German. It is unfortunate for the English reader that no synopsis of the points made by the author is given either in French or German. Professor Bobretzky is also the author of a work on the embryology of the Crustacea, published at Kiew in 1873, and of later works on the same subject. Russia is rapidly taking the foremost rank in zoölogy. In comparative embryology she is at this moment on the whole in advance of England, the United States, or France. Such embryologists as Kowalevsky, Metznikoff, Bobretzsky, Ganin, Melnikow, and Ussow, nearly all, we believe, trained in German universities, have carried Russian biological science to high-water mark.

NINTH ANNUAL REPORT OF THE U. S. GEOLOGICAL AND GEOGRAPHICAL SURVEY OF THE TERRITORIES.[2] — This Report shows the work done by the Survey in Colorado during 1875. Dr. Hayden announces that a map of the State is nearly ready, and when finished "Colorado will have a better map than any other State in the Union, and the work will be of such a character that it will never need to be done again. Colorado will never support so dense a population that a more detailed survey will be required."

The Report forms a bulky volume of over eight hundred pages. Part I., *Geology*, contains the report of Dr. C. A. Peale, F. M. Endlich and W. H. Holmes, and B. F. Mudge. Part II., *Geography and Topography*, comprises the reports of A. D. Wilson, Henry Gannett, G. B. Chittenden and G. R. Bechler. Part III., *Zoölogy*, contains the History of the American Bison, by J. A. Allen, and a Report on the Rocky Mountain Locust and other Insects now injuring or likely to injure Field and Garden Crops in the Western States and Territories, by A. S. Packard, Jr.

LIST OF THE VERTEBRATED ANIMALS IN THE LONDON ZOÖLOGICAL GARDEN.[3] — This list forms a bulky volume, handsomely illustrated with

[1] *Untersuchungen über die Entwickelung der Cephalopoden.* Von DR. N. BOBRETZKY aus Kiew. (Nachrichten der K. Gesellschaft der Freunde der Naturerkenntniss, Anthropologie und Ethnographie bei der Universität Moskow. Bd. xxiv. Heft 1, Moscow, 1877. 4to, pp. 73, with ten plates.

[2] *Ninth Annual Report of the U. S. Geological and Geographical Survey of the Territories, embracing Colorado and Parts of adjacent Territories.* Being a Report of Progress of the Exploration for the year 1875. By F. V. HAYDEN, U. S. Geologist. Washington, 1877. 8vo, pp. 827, with seventy plates and numerous maps.

[3] *List of the Vertebrated Animals now or lately living in the Gardens of the Zoölogical Society of London.* Sixth edition. 1877. London. 8vo, pp. 519.

thirty wood-cuts of many rare birds and mammals, and forms a nearly complete catalogue of all the living vertebrates received by the society during the past ten years. The volume will prove of a good deal of interest to the general student of these animals.

RECENT BOOKS AND PAMPHLETS. — Annual Report of the Board of Regents of the Smithsonian Institute. Washington. 1877. 8vo, pp. 488.

On the Nymph Stage of the Embidæ. By R. M'Lachlan. (Extracted from the Journal of the Linnean Society, Zoölogy, vol. xiii.) 8vo, pp. 11, 1 plate

The Post-Tertiary Fossils procured in the Late Arctic Expedition; with Notes on some of the Recent or Living Mollusca from the Same Expedition. By J. Gwyn Jeffreys. (From the Annals and Magazine of Natural History for September, 1877.) 8vo, pp. 12.

A Catalogue of the Birds of the Vicinity of Cincinnati, with Notes. By Frank W. Langdon, Naturalist's Agency. Salem, Mass. 1877. 8vo, pp. 17.

On the Tenacity of Life of Tape-Worms and their Larval Forms in Man and Animals. By Prof. Edward Perroncito. (Annali della Reale Accademia d'Agricoltura, 1876.) 8vo, pp. 4.

Members and Correspondents of the Academy of Natural Sciences of Philadelphia. 1877. 8vo, pp. 46.

Address to the Biological Section of the British Association, Plymouth, August, 1877. By J. Gwyn Jeffreys. London. 1877. 8vo, pp. 9.

The Summer Birds of the Adirondacks in Franklin County, New York. By Theodore Roosevelt, Jr., and H. D. Minot. 8vo, pp. 4.

Palæontological Bulletin. No. 25. Verbal Communication on a New Locality of the Green River Shales, containing Fishes, Insects, and Plants in a good State of Preservation. Made by E. D. Cope, before the American Philosophical Society, July 20, 1877. 8vo, pp. 10.

Notes of a New Genus of Annelids from the Lower Silurian. By George Bird Grinnell. (From the American Journal of Science and Arts. Vol. xiv. September, 1877.) 8vo, pp. 2.

GENERAL NOTES.

BOTANY.[1]

POISONOUS GRASSES. — In the September number of *Trimen's Journal of Botany* there is an interesting note by Dr. Hance on Intoxicating Grasses, which supplements a previous article on the same subject. A grass was sent by Dr. Aitchison from Kashmir which Professor Dyer determines as *Stipa Sibirica* Munro. Concerning this grass, Dr. Aitchison writes (date of August 4, 1875): "I have just been collecting some good specimens of a grass that is extremely common near Gulmuz. It grows in large tussocks, and is very poisonous to horses and cattle. The cattle are too knowing and will not eat it. Horses from the plains do eat it and die from its effects, but if quickly treated recover. They become comatose and lose the power of their limbs. It grows in the Scinde Valley also. Whilst there I heard of it and the cure, namely, smoking them, by making a large fire and keeping the horse's head in

[1] Conducted by PROF. G. L. GOODALE.

the smoke. The nose commences to run first, and if it does so freely the beast is safe. The natives also say that if a cow eats it they give acid, unripe apricots, or any vinegar, which aids the recovery. A large number of the horses this year at Gulmuz were poisoned by it; none died, as all smoked their horses." In Dr. Hance's previous article, mention was made of a statement by a French missionary which is materially identical with the above. Professor Dyer suggests in a note to Dr. Hance that the Stipas may be only mechanically poisonous, like *Hordeum pratense*, but Dr. Hance adds that though it is indisputable that various grasses in Europe and Australia cause injury or death to cattle from their irritant properties, the special symptoms in the case of the *Stipa* and in *Melica* seem opposed to such a supposition. "In a recently published translation of Ptzevalsky's travels the Alashan poisonous grass is said to be a species of *Lolium*, and it is added that the native herds carefully avoid eating it."

In the September number of the *Botanical Gazette* Dr. J. T. Rothrock has a short note upon the *Leguminosæ* poisonous to stock. These plants are *Oxytropis Lamberti* in Colorado, *Hosackia Purshiana* in Arkansas, and two or three species of *Astragalus* in California.

A Remarkably Large Ostrya Virginica. — Mr. Robeson, of Lenox, has sent me the dimensions of a remarkable plant of *Ostrya Virginica*, which I found last summer growing near the roadside in West Stockbridge, Mass. I place it on record because it is more than twice as large as the specimens of this species mentioned in any of the works on American trees. Larger specimens, if they anywhere exist, should be reported, that more accurate information may be obtained on the development, under favorable conditions, of this tree. Mr. Robeson's measurements are, girt of stem at the ground 9 feet 11 inches, at 4 feet from the ground 7 feet 2 inches; height to first branches 6 feet 4 inches; spread of branches from east to west 47 feet, from north to south 45 feet; height of tree 48 feet 7 inches. — C. S. Sargent.

Alpine Plants. — Mr. C. G. Pringle, of Charlotte, Vermont, offers for exchange or sale a few sets of the Alpine plants of New England, the fruit of his extensive herborizing during the past summer in the White and Green mountains. Mr. Pringle's collections contain *Gentiana Amarella* var. *acuta* (American Naturalist, volume ii., page 620), *Anemone multifida*, *Astragalus Robbinsii*, *Gnaphalium supinum*, *Orchis rotundifolia*, *Danthonia compressa*, and all or nearly all the other rare plants of his region.

How Plants guard against Animals and Bad Weather is an English title for a German work which has been lately issued as a supplement to *Botanische Zeitung*. Otto Kunze, the author, has brought together within small compass a vast number of most interesting facts respecting the means by which plants protect themselves against animals and unfavorable weather. He has also presented the results of some

studies in regard to the relations of plants to salt water, noting particularly the difference in habit between maritime plants and those of the interior. After this follow some unfinished geological speculations.

BOTANICAL DIRECTORY. — We call attention to the following notice by Mr. Leggett: "In view of the great utility to botanists of a full and correct directory, your aid is invited to render the new edition as complete as possible. It should include all botanical workers in America in every department; also libraries and herbaria valuable as references for their extent or special riches; also botanical societies and gardens. Specialties and a desire to exchange should be noted. It is hoped to issue the work about December 1st. The price will be for a single copy 40 cents; three copies for $1.00; a dozen for $3.00. Address Wm. H. Leggett, 54 East 81st Street, New York."

SCIENTIFIC GERMAN. — Under this title a work has been prepared by Mr. H. B. Hodges, instructor in chemistry and German in Harvard University. It is designed to aid students in acquiring a practical knowledge of the words, phrases, and general style of German writers upon scientific subjects. The portions of the work devoted to botany are very valuable. First are given lessons on histology, morphology, and physiology; after which follow selections from recent works by well-known authors. Of those most interesting to our botanical readers we will mention: Grisebach, On the Influence of Forests upon Climate; Liebig, On the Origin of Arable Soil, and Humus; Sachs, On Movements of Plants. The volume exhibits great painstaking, and excellent judgment throughout. The vocabulary is copious and accurate, and will prove of great use to readers of the recent German works on botany.

CATALOGUE OF WISCONSIN PLANTS. — Th. A. Bruhin, of Centreville, Wis., communicates (date of April, 1876) to the Zoölogical and Botanical Society of Vienna a list of the plants of his State. The catalogue is prefaced by three shorter lists: first, the names of plants supposed to be common originally to the flora of Europe and Wisconsin. Of the 239 species, 122 are dicotyledons, 85 are monocotyledons, the remaining 32 are vascular cryptogams. The second list comprises the plants carried from America to Europe and now growing wild there, and some of those more frequently cultivated, together 35 species. In the third list are the 176 European plants introduced into Wisconsin. From these lists we learn that 450 species are common to Wisconsin and Europe.

THE SIZE OF THE LEAVES OF AUSTRIAN WOODY PLANTS. — In this memoir, Dr. Pokorny presents what he calls a phyllometric method, and which he believes is applicable to many leaves of shrubs and trees. He describes three transverse axes which cross the median line at right angles. The first of these is distant from the base of the leaf blade one fourth the length of the leaf; the second divides the leaf into halves; the third is midway between this line and the apex of the leaf. The ratios existing between these axes should give exactness to the terms applied

to the forms of leaves. That our readers may make the attempt to utilize these ratios, we here transcribe the set given in the diagrams.

The longitudinal axis is assumed to be in all cases 100. say millimetres, or any units of measurement.

The first transverse axis, that which cuts the longitudinal midway between the base of the leaf and its middle point, is called B_1; the second, at the middle, is B_2; the third, midway between this and the apex, is B_3.

B_3 8.6	B_3 5.	B_3 5.
B_2 10.	B_2 10.	B_2 10.
B_1 8.6	B_1 5.	B_1 8.6
Elliptical,	Rhombic,	Ovate.
B_3 8.6	B_3 3.3	B_3 2.5
B_2 10.	B_2 6.7	B_2 5.
B_1 5.	B_1 10.	B_1 7.5
Obovate,	Deltoid,	Triangular.

The different woody plants of Austria have been studied by Dr Pokorny with respect to the ratios of these axes in the leaves, and the results are given in detail in the twenty-seventh volume of the Transactions of the Zoölogical and Botanical Society at Vienna.[1]

Botanical Papers in Recent Periodicals. — *Botanical Gazette.* September. Dr. J. T. Rothrock, On Poisonous Properties of Leguminosæ. (Elsewhere noticed.) Professor Lockwood, Shipping Live Plants. (The plants were *Nymphæa lutea* and *odorata*, *Helonias bullata*, *Erythronium Americanum*, *Claytonia Virginica*, *Thalictrum anemonoides*, *Pyxidanthera barbulata*, and an amaryllis. The roots of these plants were surrounded by moist plastic clay, and then securely packed in a cask with sand. They were shipped on May 9th, and were received at Sydney, Australia, late in June. The *Pyxidanthera* was dead, but the species of Nymphæa were in good condition, and all the rest alive.) G. E. Davenport, Vitality in Ferns. (A plant of *Polypodium vulgare* was kept in a warm room in a perfectly dry state from November, 1876, until April, 1877. "It had become so dry and shriveled that it did not seem possible for any life to exist; yet under the influence of frequent rains it soon began to start, and is now (August 3) growing moderately.") Several notes respecting collections in Southwestern Virginia and in Missouri are given by Messrs. Shriver, James, and Barnes.

Trimen's Journal of Botany. September. H. Trimen, On *Lavatera sylvestris*, in Britain. J. G. Baker, On Brazilian Species of Alstromeria. G. S. Jenman, Ferns new to Grisebach's Flora of the West Indies. H. F. Hance, On Intoxicating Grasses. (Elsewhere noticed.) H. F. Hance, *Thorelia*, a New Genus of Lythraceæ. Baron von Mueller, List

[1] Verhandlungen der Kaiserlich-Königlichen Zoölogisch-Botanischen Gesellschaft in Wien, 1877.

of Mr. Gile's Australian Plants. Three excellent abstracts of German memoirs are given.

Botanische Zeitung, No. 32. Dr. Harz, On the Origin and Properties of Spergulin (a new fluorescent from the seed-coats of *Spergula vulgaris*). Continued from the last number. Reports of Societies. No. 33. B. Ascheron, Phytographic Notes. Christoph Gobi, On Some Phæosporeæ of the Baltic. No. 34. H. G. Holle, On the Point of Growth in the Roots of Dicotyledons. No. 35. A. Morgen, On the Process of Assimilation in germinating Cress (*Lepidium sativum.*) Continued in Nos. 36 and 37. In No. 37 there is a paper by Dr. O. Drude, On the Structure and Systematic Position of the Genus *Carludovica.* The genus is assigned a place between *Pandanaceæ* and *Palmeæ.* No. 38. Dr. O. Drude, Selected Examples to explain the Formation of the Fruit in Palms. Rostafinske, of Cracow, A Reply to Certain Criticisms by Reinke.

ZOÖLOGY.[1]

DESTRUCTION OF BIRDS BY TELEGRAPH WIRES. — Referring to Dr. Coues's article on this subject, in the NATURALIST and elsewhere, I wish to add my testimony to the destruction of much larger birds than any mentioned by this writer. Many prairie chickens (*Cupiaonia cupido*) are annually destroyed in this way. In December, 1868, near Cambridge, Story County, Iowa, I saw many of these birds lying dead on the snow, beneath the line of the telegraph, and was informed by the stage driver that they killed themselves by striking the wire in their rapid flight. Some of the birds had their heads cleanly cut off, and most of them were torn and lacerated to a greater or less extent. One or two of the wounded were still alive and fluttering. The spot seemed to be a favorite one for the flight of the chickens. A high belt of timber skirted the river, and beyond this lay the mile-wide expanse of "Skunk Bottom," bounded by high bluffs on the east. For certain reasons — possibly owing to some peculiarity of the winds at this point, or to the protection afforded by the belt of timber — the birds were accustomed to speed like arrows down across this bottom, and slight contact with the single wire that stretched across would either maim or kill them outright. Since that time I have heard of several instances in which these birds have been killed in the same manner. The destruction of these birds is so general along some of the railroad lines in the West that section men make a regular business of gathering them up as an addition to their own stock of provisions. The telegraph wires may therefore be set down as one of the means — and not an insignificant one — whereby the extermination of the prairie hens is proceeding with a degree of rapidity which would be astonishing had we any means of mak-

[1] The departments of Ornithology and Mammalogy are conducted by Dr. ELLIOTT COUES, U. S. A.

ing even an approximate calculation. — CHARLES ALDRICH, Webster City, Iowa.

FOOD OF THE SKUNK. — In his recently published most admirable monograph on the North American Mustelidæ, Dr. Elliott Coues, writing of the "common skunk" (*Mephitis mephiticus*), says, "They feed largely upon insects, birds, eggs, such small reptiles as frogs, small quadrupeds, such as the various kinds of mice," and adds; that "they are also said to capture rabbits in the burrows in which the timorous beasts sometimes take refuge, though they are manifestly incapable of securing these swift-footed animals in the chase." He likewise refers to the well-known fact of their depredations on poultry-yards. Some years ago I shot one of these animals near the celebrated "Walled Lake," in Wright County, Iowa, at the entrance of a burrow where it would seem that they had lived and multiplied and half-hibernated during many generations, for their excrements formed quite a mound around the entrance of their habitation. This refuse was composed almost wholly of the hinder portions of the craw-fish, which swarmed in the sloughs and ponds of the surrounding prairie. The animal matter had of course disappeared in the process of digestion, and the accumulations had bleached out so as to look like a heap of lime, — as it really was, — in every part of which were fragments of the limbs and external parts of these craw-fish of the prairie. The heap was so large that it at once suggested the idea that it must have been deposited by larger animals; but some portions were quite recent, while the hole was too small to admit any of our larger prairie mammals, such as the wolf, fox, or badger Hence I concluded that the craw-fish formed a staple portion of the food of this "*enfant du diable*," as the old French naturalist termed it before science had given it so many names. — CHARLES ALDRICH.

TENACITY OF LIFE SHOWN BY SOME MARINE MOLLUSKS. — In 1875 I collected on several of the Florida keys *Littorina muricata* L. in quantities. This was in February. I brought home quite a number alive and put them in my barn, intending to let the animals die and the shells lose their odoriferous qualities before transferring them to my collection. What was my surprise to find the animals still alive in April, two months after they were collected. They had not been exposed to moisture during the time. The last of them died in May. Again, only last winter, I collected at St. Augustine, Florida, *Littorina irrorata* Say, putting them in tin cans and boxes which in due course of time arrived home. On the first of May last I emptied the shells in a sunny place, and the animals within quickly crawled out. This was four months after I secured them. I have in my collection many Helices that have remained alive shut up in boxes for over three years, — a thing that did not surprise me, as numerous similar instances are on record; but I never before knew marine or semi-marine species to show so much tenacity of life when removed from their natural situations. — W. W. CALKINS.

NOTE ON THE MEXICAN SPERMOPHILUS. — Fresh specimens of this animal (*S. Mexicanus*), still rare in collections, have reached me through Mr. George B. Sennett, of Erie, Pennsylvania, who has lately returned with a fine collection of mammals and birds from the vicinity of Fort Brown, Texas, — a highly interesting locality, which, through the exertions of Dr. J. C. Newell, of the army, and of Mr. Sennett, has furnished various species new to our fauna. In 1857 Professor Baird had some dozen or more specimens to work upon, but no additional ones have hitherto been forthcoming, as Mr. Allen's monograph just published catalogues none. Mr. Sennett's specimens are in fine order, and correspond precisely with Baird's and with Allen's elaborate descriptions. — ELLIOTT COUES, Washington, D. C.

PAPILIO CRESPHONTES IN NEW ENGLAND. — On the 6th of last September, Mr. N. Coleman captured in the vicinity of Berlin, Connecticut, the only specimen of this Southern insect ever recorded from New England. As the larva is not known to feed on any other plant than the orange, the butterfly probably hatched from a larva accidentally transported with trees from Florida, or emerged from a chrysalis sent North as a curiosity.

ANTHROPOLOGY.

EXAMINATIONS OF INDIAN MOUNDS ON ROCK RIVER, AT STERLING, ILLINOIS. — I recently made an examination of a few of the many Indian mounds found on Rock River, about two miles above Sterling, Illinois. The first one opened was an oval mound about twenty feet long, twelve feet wide, and seven feet high. In the interior of this I found a *dolmen* or quadrilateral wall about ten feet long, four feet high, and four and a half feet wide. It had been built of lime-rock from a quarry near by, and was covered with large, flat stones. No mortar or cement had been used. The whole structure rested on the surface of the natural soil, the interior of which had been scooped out to enlarge the chamber. Inside of the dolmen I found the partly decayed remains of eight human skeletons, two very large teeth of an unknown animal, two fossils, one of which is not found in this place, and a plummet. One of the long bones had been splintered; the fragments had united, but there remained large morbid growths of bone (exostosis) in several places. One of the skulls presented a circular opening about the size of a silver dime. This perforation had been made during life, for the edges had commenced to cicatrize.

I later examined three circular mounds, but in them I found no dolmens. The first mound contained three adult human skeletons, a few fragments of the skeleton of a child, the lower maxillary of which indicated it to be about six years old. I also found claws of some carnivorous animal. The surface of the soil had been scooped out, and the bodies

laid in the excavation and covered with about one foot of earth; fires had then been made upon the grave, and the mound afterwards completed. The bones had not been charred. No charcoal was found among the bones, but occurred in abundance in a stratum about one foot above them. Two other mounds examined at the same time contained no remains.

Of two other mounds opened later, the first was circular, about four feet high, and fifteen feet in diameter at the base, and was situated on an elevated point of land close to the bank of the river. From the top of this mound one might view the country for many miles in almost any direction. On its summit was an oval altar, six feet long and four and one half wide. It was composed of flat pieces of limestone, which had been burned red, some portions having been almost converted into lime. On and about this altar I found abundance of charcoal. At the sides of the altar were fragments of human bones, some of which had been charred. It was covered by a natural growth of vegetable mold and sod, the thickness of which was about ten inches. Large trees had once grown in this vegetable mold, but their stumps were so decayed I could not tell with certainty to what species they belonged. Another large mound was opened which contained nothing. — W. C. HOLBROOK.

CHRISTENING CEREMONY OF THE SEMINOLE INDIANS. — The Seminole Indians, now inhabiting the Indian Territory, were formerly in the habit of performing the following ceremony at the christening of their male children: At about the age of fourteen the boy was scratched or incised, with a sharp flint, six times on each arm and leg, the length of the incisions being about a foot. If the subject flinched or cried out, he was given an insignificant name, and was not considered worthy to be a warrior; but if he bore the operation manfully he was given a high-sounding title, and was destined to become a great man in the tribe. — E. A. BARBER.

MAN IN THE PLIOCENE IN AMERICA. — The evidence, as it stands to-day, although not conclusive, seems to place the first appearance of man in this country in the Pliocene, and the best proof of this has been found on the Pacific coast. During several visits to that region, many facts were brought to my knowledge which render this more than probable. Man at this time was a savage, and was doubtless forced by the great volcanic outbreaks to continue his migration. This was at first to the south, since mountain chains were barriers on the east. As the native horses of America were now all extinct, and as the early man did not bring the Old World animal with him, his migrations were slow. I believe, moreover, that his slow progress towards civilization was in no small degree due to this same cause, the absence of the horse.

It is far from my intention to add to the many theories extant in regard to the early civilizations in this country, and their connection with the primitive inhabitants, or the later Indians; but two or three facts have

recently come to my knowledge which I think worth mentioning in this connection. On the Columbia River, I have found evidence of the former existence of inhabitants much superior to the Indians at present there, and of which no tradition remains. Among many stone carvings which I saw there, were a number of heads which so strongly resemble those of apes that the likeness at once suggests itself. Whence came these sculptures, and by whom were they made? Another fact that has interested me very much is the strong resemblance between the skulls of the typical mound-builders of the Mississippi Valley and those of the Pueblo Indians. I had long been familiar with the former, and when I recently saw the latter, it required the positive assurance of a friend who had himself collected them in New Mexico to convince me that they were not from the mounds. A third fact, and I leave man to the archæologists, on whose province I am even now trenching. In a large collection of mound-builders' pottery, — over a thousand specimens, — which I have recently examined with some care, I found many pieces of elaborate workmanship so nearly like the ancient water-jars from Peru that no one could fairly doubt that some intercourse had taken place between the widely separated people that made them.

The oldest known remains of man on this continent differ in no important characters from the bones of the typical Indian, although in some minor details they indicate a much more primitive race. These early remains, some of which are true fossils, resemble much more closely the corresponding parts of the highest Old World apes than do the latter our Tertiary primates, or even the recent American monkeys. Various living and fossil forms of Old World primates fill up essentially the latter gap. The lesser gap between the primitive man of America and the anthropoid apes is partially closed by still lower forms of men, and doubtless also by higher apes, now extinct. Analogy, and many facts as well, indicates that this gap was smaller in the past. It certainly is becoming wider now with every generation, for the lowest races of men will soon become extinct, like the Tasmanians, and the highest apes cannot long survive. Hence the intermediate forms of the past, if any there were, become of still greater importance. For such missing links, we must look to the caves and later Tertiary of Africa, which I regard as now the most promising field for exploration in the Old World. — Professor Marsh's Address at Nashville as Vice President of the American Association.

ANTHROPOLOGICAL NEWS. — The Rev. S. D. Peet, of Ashtabula, Ohio, has assumed the editorship of the *American Antiquarian*, a quarterly journal of correspondence on American archæology, ethnology, and anthropology; price $2.00 per annum. We have announced by the same gentleman A Manual of Archæology; being a Complete Analysis and Compendium of the Science, designed especially for Beginners.

The *Journal of the Anthropological Institute* announces for the August number the ollowing pape frs of general interest: Primitive Agriculture, A. W. Buckland; Non-Sepulchral Rude Stone Monuments, M. T. Walhouse; The Himalayan Origin of the Magyars, Hyde Clarke; The Brain Weight of some Chinese and Pelew Islanders, Dr. Crochley Clapham; Right-Handedness, James Shaw; The Mental Progress of Animals during the Human Period, James Shaw.

During the meeting of the British Association in Plymouth, excursions were made to Totnes, Torquay, and Brixham caves. The opening address before the geological section, by Mr. Pengelly, was an elaborate report of the exploration of caves in the vicinity of Plymouth, including the Orestin caverns, Kent's Hole, Yealm Bridge caverns, the Ash Hole, Brixham Cavern, Windmill Hell, and Ansty's Cave. The following papers were among those read before the anthropological department: Francis Galton, On a More Accurate and Extensive Method of Observations on those Groups of Men who are sufficiently Similar in their Mental Characters or in their Physiognomy, or in Both, to admit of Classification; Dr. Beddoe, On the Bulgarians; Dr. Phéné, On the District of Mycenæ, and its Early Inhabitants; Park Harrison, On Characters found in the Sides of the Tunnels driven into the Chalk of Sussex; Mr. Sorby, On the Coloring Matter of the Human Hair; Miss A. W. Buckland, Ethnological Hints afforded by the Stimulants of Ancient and Modern Savages; Mr. A. Simpson, Who are the Zaparoz, a Tribe of Ecuador; Mr. Hunter, On the Natives of Socotra; B. Hartshorne, Ancient People and Irrigation Works in India; Professor Rolleston, On the Rationale of Brachycephaly and Dolicocephaly; Artificial Deformation of the Head; The Fauna and Flora of Prehistoric Times. There were about thirty papers read before this department.

The American Association had such a poor showing of anthropologists on the first day that the subsection was merged into the section of biology. The members came in a little later, and Monday, August 31st, was assigned to them. The opening address of the president, Dr. Daniel Wilson, of Toronto, was partly a *résumé* of anthropological science, and partly an invitation to cultivate the speaker's peculiar field, namely, the ethnological problems that are being worked out on the American continent by the mingling of many races under various climatic and social conditions. Among the papers read are the following: The American Indians of North America, Henry C. Carrington; All Life conditionally Immortal, William Bross; Additional Facts concerning Artificial Perforations of the Cranium in Ancient Mounds in Michigan, Henry Gilman; Introduction to the Study of Indian Languages, J. W. Powell; Report on the Exploration of the Graves of the Mound Builders in Scott and Mississippi Counties, Missouri; Some Observations on the Skull of the Comanches, T. O. Summers. Colonel Garrick Mallery read a very elaborate paper on the probability that

there has been no diminution in the number of the Indians of the North American continent since the first settlement. The author took the ground that the works which are supposed to have taken great numbers to accomplish them were rather the results of long-continued labor. This statement in opposition to the almost unanimous opinion of writers on our Indians was the subject of considerable attention. Professor Marsh in his address before the section of biology took occasion to say that while the primates originated on the American continent, the absence of higher fossil forms argues their subsequent migration, and consequently the impossibility of man's having originated in our hemisphere.

The Davenport (Iowa) Academy of Natural Science has issued volume ii. part i. of its Proceedings. Among the valuable contributions to archæology, the one which will attract the most attention is the description, by the Rev. J. Gass, of his discovering in a mound tablets of soft shale, having elaborate inscriptions scratched on them. One represents a hunting party, another a cremation scene, and a third is a supposed calendar.

In addition to the antiquities already mentioned from Porto Rico and described in the Smithsonian Report for 1876, Professor Baird has just received from Mr. Lewis Jones R. Brace, of Nassau, N. P., drawings of celts, images, and stools, differing from those already described only in detail. Among the specimens are two wooden stools, one of which is the long-tailed variety sent by Messrs. Gabb and Frith. The other is a short-tailed variety, and resembles very much a shallow dish. I have seen similarly shaped, so-called mortars or metates from Central America, made to resemble a quadruped, the head projecting in front and the tail twisted around for a handle.

The Smithsonian Annual Report for 1876, just published, is in some respects the most interesting number ever issued.

Dr. Paul Broca, the distinguished anthropologist, presided over the French Association this year. In his opening address he gave a *résumé* of the fossil races of Western Europe, dividing them as follows: —

1. Canstadt Race, the oldest (dolicocephalic).
2. Cromagnon Race (").
3. Furfooz Race (brachycephalic).

Authors of anthropological treatises and papers, desiring to have them noticed in Baird's Annual Record, will please send copies to Professor S. F. Baird or to O. T. Mason, Washington, D. C. — O. T. Mason.

GEOLOGY AND PALÆONTOLOGY.

Discovery of Jointed Limbs in Trilobites. — In a paper entitled Notes on Some Sections of Trilobites from the Trenton Limestone, published in advance of the report of the New York State Museum of Natural History, Mr. C. D. Walcott describes and figures jointed limbs in

Calymene and Ceraurus. It will be remembered that the nature of the limbs of trilobites has been long a matter of controversy, some believing they had soft, membranous limbs, and others that they had jointed limbs, like those of the king crab (Limulus) and the fossil Eurypterus, etc., and still others that they may have had anterior ambulatory jointed limbs, and posterior broad membranous swimming abdominal appendages. Mr. Walcott, after making many sections of trilobites, has discovered jointed appendages in them, numerous sections of *Calymene senaria* showing axial appendages with three joints; "the third joint in all appendages of this species seen (seventy-seven in number) terminates in a round, blunt end." In *Ceraurus pleurexanthemus* the limb is five jointed. The legs end in a single blunt end, and Mr. Walcott is inclined to think the legs will be found to have "five or six joints with a terminal claw."

"Attached to the basal (?) joint of the leg there is a slender-jointed arm of two, and probably three joints. Portions of pinnulæ are attached to the terminal joint. Whether they are branchial tubes cannot be satisfactorily determined from the section. In other sections rows of pinnulæ are shown which are undoubtedly branchial tubes. From the character of the remaining portion of the respiratory apparatus they must have been attached to the arm. It is also quite probable that a branchia was attached to the basal joint of the arm. It may be that its occurrence in this position in the section, is owing to a displacement of one of the branchiæ attached to the side of the thoracic cavity. These branchiæ are attached above the basal joint of the leg. The branchia in *Calymene senaria* projects out a short distance and then bifurcates, sending two spirals nearly to the edge of the dorsal shell. In some sections the base appears to be a portion of the ribbon or band forming the spiral straightened out, while in others it is a closely coiled spiral. At the bifurcation the outer spiral springs from the base which continues on to form the inner spiral."

A transverse section of the head of Calymene cut so as to cross the hypostoma just within the posterior end, exhibited a space filled with calc-spar, which "is the continuation of the visceral cavity of the thorax." From the lower lateral margin of each side a jointed appendage extends outward and downward. "Between the upper pair of appendages and the glabella three pairs of appendages project. Their basal joint is slender, and, in two sections, closely resembles the maxillary joint of the leg of the Eurypterus, modified in form, but undoubtedly subservient to the same use as a part of the mouth." Sections of *Asaphus platycephalus* furnish evidence that it had axial appendages of essentially the same structure as those of Calymene and Ceraurus.

Mr. Walcott concludes that the homology between the parts about the mouth of the trilobite and the same organs in the *Eurypterida* and *Xiphosura* is very direct and relates the families closely, and he considers that the *Xiphosura*, *Eurypterida*, and *Trilobita* form the legion Me-

rostomata and subclass Gnathopoda. Having ourselves, from a study of the king crab and the tegument of the trilobites, and from the suggestions of Billings regarding the nature of the appendages of the trilobites, arrived at the conclusion that the trilobites most probably had jointed ambulatory limbs as well as membranous swimming appendages, it is gratifying to find what was before a matter of probability, actually demonstrated by the patient toil and well sustained energy of Mr. Walcott.

The discovery of the nature of the limbs of trilobites "adds a fresh laurel," to use a fossilized expression, to American palæontology.

The Greenland Glaciers. — Amund Helland, of Christiania, Norway, made in 1875 a journey to North Greenland, and gives in the *Quarterly Journal of the Geological Society of London* (No. 129), the results of his comparisons of the glacial phenomena of that country with those of Norway. He has overlooked the writings of Americans who have visited Greenland, and he probably never saw the magnificent work in folio of our marine artist, William Bradford of New York, which contains many photographs of the Greenland glaciers, and possesses a good deal of scientific value. Helland believes that "the thickness of the inland ice near its border cannot exceed 250 metres, and is probably not more or is even less than 200 metres; but since its surface rises as we proceed inland, its thickness may possibly increase in that direction."

"The amount of precipitation in North Greenland seems to indicate indirectly the great extent of the inland ice; for where the glaciers are largest it is not considerable; at the colony of Jakobshavn the rainfall from July, 1873, to July, 1874, was 219.7 mm., from July, 1874, to July, 1875, 183.7 mm. In the district of Umanak, where there are a number of great ice-fjords, the rainfall seems to be no greater; yet here the glaciers are very large, one may say the largest known; so that we can only account for them by supposing that they are supplied from a very extensive upland district on which there is a considerable snow fall, and thus that there can be little land in the interior free from ice. Be this as it may, there is no doubt that the ice-sheet extends into Greenland beyond the range of vision."

The fact, he says, that though the climate of Greenland is rather dry large glaciers are numerous, is not without geological importance, as showing that a great snow fall is not absolutely necessary for the glaciation of an extensive country. "It is also remarkable that the glaciers are supplied from an ice-field which, to a large extent at least, lies below the limit of perpetual snow." He contends that Greenland is not a collection of islands, but a fjord land like Norway or the coast of North America.

He found that the Jakobshovn glacier flows with a velocity greater than any that has hitherto been observed, the greatest daily motion observed being 22.46 metres, from July 8th, seven P. M., to July 9th, ten A. M., while the slope of the land is only half a degree. The maximum daily

motion as observed by Professor Tyndall on the Mer de Glace (Chamouni) was 33⅗ inches (0.85 metre) in June.

"The rate of flow, already mentioned, has an important bearing on the theory of glacier-motion. As the slope of the Jakobshavn glacier, which has the extraordinarily rapid motion of twenty metres *per diem*, is only half a degree, the fall of the bed of the valley cannot be the most important factor in the motion of glaciers. This considerable velocity must be due to the quantity of ice which has to be carried out to the fjord; or, in other words, the rate of motion is dependent on the pressure of the mass of the inland ice. Glaciers, therefore, fed from large districts of atmospheric precipitation, move with considerable velocity."

Helland thinks it doubtful if the ice-sheet and the glaciers would form again could the land be denuded of them and left to the influences of the present climate.

The author also discusses in an interesting way the formation of cirques and lake basins in Norway and Greenland, but the views of Ramsay and others which he supports are becoming antiquated.

GEOGRAPHY AND EXPLORATION.

Stanley's Journey across Africa. — Following the journey of Cameron across the continent of Africa from coast to coast, we have the adventurous march of Stanley, who arrived at Loanda, on the west coast, August 21st. From a *résumé* in the *Nation* we learn that he began his journey in November, 1874, at Bagamoyo, on the east coast. He was a year and a half reaching Ujiji, but meanwhile had surveyed the Victoria Nyanza, had crossed the intervening divide to the Albert Nyanza, and had explored the Alexandra Nile. He next, after visiting Lake Tanganyika, followed up the Lukuga, which Cameron had considered a genuine outlet to the lake, but which Stanley claimed was only such in exceptionally high water. In November, 1876, he set out through Uregga, crossed the left bank of the Lualaba, and passed around a series of cataracts, situated just north and south of the equator. "At 2° N. latitude the northerly course of the river bends to the northwest, then to the west, and finally to southwest, where its width is from two to ten miles, and the stream is choked with islands." This river was called Congo by the natives. On the 8th of August, 1877, Stanley arrived at Boma, at the head of the Congo delta; on the 14th, at Cabinda, on the coast; and on the 21st at S. Paulo de Loanda. "His party (114 in number) was greatly reduced by dysentery, scurvy, and ulcers, and his last white comrade, Francis Pocock, had perished by being carried over one of the cataracts. His faithful body-servant, Kalulu, was also among the missing. The importance of Stanley's discoveries, in a geographical point of view, cannot be overestimated. They take rank among the foremost of the century, and are destined to give a new impulse and direction to exploration in Central Africa. Hitherto geographers had not conjectured that

the course of the Congo approached the equator, but it is now evident that the river can be reached by a short cut from the Albert Nyanza, or from Schweinfurth's river Welle. This stream, if it should not prove a tributary of the Congo, may not impossibly be the upper portion of the Ogove, the last great river on the West African coast whose origin is a mystery."

GEOGRAPHICAL NEWS. — A new interest in Arctic Exploration has been excited in this country by the departure of Captain Howgate's vessel, Florence, for Cumberland Island, the first stopping-place on the way to Smith's Sound. The *Geographical Magazine* is urging the continuance and completion of polar discovery on the part of the English government, and says that four routes now remain for future expeditions. (1.) The Jones Sound route, the work of which will be to connect North Lincoln with Aldrich's farthest, and to ascertain the limits of the Palæocrystic sea in that direction. (2.) The East Greenland route, to connect Cape Bismarck with Beaumont's farthest, and so complete the discovery of Greenland. (3.) The route of Franz Josef Land, to explore the northern side of the country discovered by Payer; and (4) the Northeast Passage, by which a knowledge of the sea north of Siberia will be completed, and Wrangell Land will be explored. On the whole the editor suggests that the East Greenland route is the best that can be selected for a new expedition. Lieutenant Weyprecht, who commanded the Austrian Polar Expedition that discovered Franz Josef Land in 1874, and Count Wilczek, one of the promoters of that expedition, have announced to the Royal Society of Meteorology of Utrecht that they intend to undertake an expedition to the Arctic regions, which will be away for about twelve months, and that they intend to establish their station of observation in one of the northern havens of Novaya Zemlya. A translation of Dr. Rink's Danish Greenland, its People and its Products, the standard work on Greenland, has been published by H. S. King & Co., London, and is a very timely work.

Several books on Turkey have appeared in London: Turkey in Europe. By James Baker. Third edition (Cassell, Petter, & Galpin, London, Paris, and New York), 1877. Travels in the Slavonic Provinces of Turkey in Europe. By G. Muir Mackenzie and A. P. Irby, with a preface by the Right Hon. W. E. Gladstone, M. P. In two volumes, second edition (London: Daldy, Isbister, & Co.), 1877. Montenegro, its People and their History. By the Rev. W. Denton, M. A. (London: Daldy, Isbister, & Co.), 1877. Handbook of the Seat of War. Edited by Alexander Mackay (London : Simkin, Marshall, & Co.), 1877.

The preservation of forests in New Zealand is attracting attention, as the colonists, by indiscriminate waste of trees, are threatening future disaster to the water supply, agriculture, and the health of the people. It appears that Frnce has suffered cruelly from the effects of a long course of denudation, and is now trying energetically to retrieve the errors of the

past. The same may be said of the United States, though increased attention has lately been paid to the planting of new and the preservation of old forests.

MICROSCOPY.[1]

THE NEW MECHANICAL FINGERS. — Several new devices for picking up and arranging diatoms, Polycystina, and other small objects have recently been described, the chief peculiarity of which consist in supporting the object from the substage, while the instrument is supported from and moved by the stage which usually bears the object-slide. By unaccountable oversight it was not stated that this expedient was the chief peculiarity of Mr. Zentmayer's mechanical finger, which was contrived in 1869, published in different journals early in the following year, and advertised and sold as a regular article of manufacture ever since. In the May number, 1870, of the *Journal of the Franklin Institute*, a cut is given of Zentmayer's invention, in which the finger is fastened to a pillar clamped to the upper plate of the mechanical stage of the microscope, while the substage is prolonged through the opening of the stage for the purpose of supporting the object. In the accompanying description Mr. Zentmayer explains that it was his object to utilize such movements of a first-class stand as were not essential for other operations connected with the use of the finger; that by attaching his apparatus to the mechanical stage he obtained sliding horizontal movements with a firmness and range not otherwise attainable; and that for the low powers employed a plain stage supported from the substage, and projecting slightly above the stage, was all that was required for holding the object and would give the necessary vertical movement to it. Mr. Zentmayer makes a special accessory to the substage for carrying the object, and a vertical adjustment to the finger itself; while subsequent experimenters have supported the object on the paraboloid or some other piece of common apparatus, and have simplified the finger by dispensing with a vertical adjustment, in both cases saving complication and expense at some loss of efficiency.

A MODIFICATION OF WENHAM'S REFLEX ILLUMINATOR. — The very ingenious and interesting reflex illuminator of Mr. Wenham was designed to avoid direct illumination by passing light into the slide at such an angle that it would be totally reflected instead of passing into air above the slide. With dry objectives, of any angle, this illumination would necessarily be exclusively reflex, since no light could pass directly to the objective; and with immersion objectives of angular aperture not greater than that corresponding to one hundred and eighty degrees dry, the result would be practically the same, as the light, after passing through a balsam-mounted object, would reach the lens at an obliquity greater than that of its extreme capacity for image-forming rays. But

[1] Conducted by DR. R. H. WARD, Troy, N. Y.

for lenses of greater angle than this, the illumination would be direct, the image being formed exclusively by that portion of the available aperture of the lens which was in excess of the equivalent of one hundred and eighty degrees dry angle. The existence, and even the possibility, of such lenses was not at that time undisputed, some eminent microscopists still maintaining the contrary opinion. But the new reflex illuminator had scarcely arrived in this country before Mr. Samuel Wells, of Boston, succeeded in making it act as a direct illuminator, with several lenses of at least two makers, an efficient and excellent image being formed by these extralimital rays. It immediately occurred to Mr. Tolles that a similarly good illumination might be obtained in the case of dry lenses, and immersion lenses of moderate angle, by changing the angle of the reflecting face so that the illuminating pencil should fall just without instead of just within the angle of total reflection. He at once made several such prisms, of various angles, but, hoping to improve still further upon the plan, refused to offer them for sale. One of these was presented by Dr. R. H. Ward at the Nashville meeting of the American Association this summer. Its reflecting face was inclined twenty-one degrees to the axis, giving an obliquity of forty-two degrees to the central reflected ray. This utilizes the extreme angle of an objective close up to one hundred and eighty degrees dry, or its equivalent in balsam, and in addition gives a slight illumination, though by itself insufficient for useful work, of extralimital rays available exclusively to immersion lenses of excessive aperture. With suitable lenses it gives prompt resolution of numbers eighteen, nineteen, and twenty of Moller's test plate in balsam, by lamp-light. The modified prisms are inferior to the original for use with lenses capable of taking up half the pencil transmitted into balsam by the original "reflex." The prism of twenty-one degrees gives the maximum efficiency with dry mounts, as the extreme capacity of the lens is utilized by the half pencil from the illuminator, which can be transmitted to it, — a condition very favorable for difficult resolution. Prisms of still smaller angles were made, and are now used for lenses of lower angle. The length of prism, and the condensing arrangement, are modified to suit the changed angle. As in the original reflex, the chromatic aberration is excessive; and it is a question how far the very decided results in resolution attained are due to the nearly perfect monochromatic illumination thus secured. The new illuminators do not seem to have given results not otherwise attainable, and they are subject to the inconvenience that each one is limited to a fixed and comparatively narrow range of angles; but they furnish a ready and easy means of oblique illumination, suitable for extremely difficult resolution, and entirely independent of thinness of stage and concentric rotation of object-carrier.

MICROSCOPIST'S ANNUAL. — The Industrial Publication Company, of 176 Broadway, New York, having undertaken to publish a list of the

prominent makers, importers, and sellers of microscopes, has extended the scope of the work to other items of interest to microscopists, and will include in the publication, to be issued annually, various tables and data, and a list of microscopical societies, their officers, etc., after the model of that originally published in the NATURALIST. The price of this convenient little work is 25 cents. Persons interested are requested to send subscriptions and data to the above address.

EXCHANGES.—Rare chemicals for the polariscope, starches, etc., offered for well-mounted slides; anatomical preparations preferred. Exchange lists printed for microscopists by papyrograph. Address G. E. Bailey, Lincoln, Nebraska.

Plumule scales of small cabbage butterfly (*Pieris rapæ*), mounted, for good slides. Address Edward Pennock, 805 Franklin Street, Philadelphia.

Shell sand from Bermuda, containing very fine foraminifera, spicules, etc., either mounted or unmounted. Address C. C. Merriman, Rochester, N. Y.

SCIENTIFIC NEWS.

— A special meeting of the California Academy of Sciences was held August 31st, for the purpose of extending a formal welcome to a trio of distinguished scientists then visiting the State, namely, Sir J. D. Hooker, C. B., Prof. Asa Gray, and Prof. F. V. Hayden. After eloquent addresses of welcome by the president of the Academy, Professor Davidson, and by Messrs. Henry Edwards and R. E. C. Stearns, Sir J. D. Hooker returned thanks for the cordial welcome given, and said he came here to learn, and not to teach, and his visit was immediately due to the experience of his old friend, Professor Gray—a friend of forty years' standing—and to the invitation of his old correspondent, Professor Hayden, whose guests they had been during the time they spent in Colorado and Utah. His acquaintance with the vegetation of America had heretofore been an extremely slight one. In association with his father's pursuits, who was for many years occupied in publishing investigations of the plants of the British possessions of North America, he was led to the investigation of the Arctic flora. In the investigation he was struck with the uniformity of vegetation extending round the whole globe in the North. There was very little difference between the vegetation of America and the Old World within the Arctic circle; but upon close examination he found that even the American flora was divisible into two sections by very slight but still definite characters; that in crossing over from Greenland to the American islands, so called, there was a distinct change in the vegetation, though very slight. The opportunity he had now had of crossing the continent of North America from east to west, had shown him that that distinction is carried out to a very much greater

extent than he had any notion of. The publications of Gray and others, had made him aware that there is a broad line of distinction between the vegetation east of the Mississippi and west of it, but he did not expect to find the variety so great as it is, and he was strongly inclined to say, though he said it under correction, that there is probably a greater difference between the east and west coasts of the American continent than there is between any two similarly related regions in any part of the globe; that you may travel from England to Spain, from Siam to China, without finding so diverse vegetations as by crossing the Mississippi and comparing the banks one hundred miles east on one side with one hundred miles west on the other. As far as the country east of the Mississippi is concerned, he was, by practical observation, almost entirely ignorant. He knew nothing of it except from the copious notes of Professor Gray conned while traveling. Since then he had the opportunity of spending some weeks in the Rocky Mountains and then of coming here, and he found a more curious difference than he had anticipated in the vegetation between the Rocky Mountains and the Sierra Nevada. He had every reason to suppose that this great difference of vegetation exists south of the parallel along which he had traveled. Time had not allowed them to digest the notes collected on the way, and more than he had announced he was not prepared to say. The president had asked him to say a few words with respect to the Academy. In England they knew well enough what it is to wait for results; but he might be believed when he said that the destinies of science on this coast are great, and a time will come that will show great results, and that will come with immense force, and for these two reasons: There is here a most intelligent and most active and progressive population, and, in the second place, there is here one of the most remarkable assemblages of natural objects and physical phenomena that any part of the world possesses. In speaking thus, he included the whole coast north and south of California. There is no section of the earth in which so many singular phenomena can be observed as in this. Without seeking to give advice, he might point out what has been the element of success in the greatest Academy of England, the Royal Society. It began with very few men, and for the best part of two centuries it was supported by what he might, without disrespect to his ancestors in science, call elderly people. It was by the elderly men who loved science, holding together congenially year after year, and almost century after century, that the young men of the society were drawn to it, and it is but lately that young men in any numbers have come into the society. For success there are three principal elements, — the holding together of the elderly members, of those who have had experience of this life in other matters than science, and who bring that experience together, with methodized common sense, of which science consists, to bear upon the objects of the society itself. In the second place, there is the important work of the secretary, together with

that of the publication committee, which should carefully pass judgment upon the communications to be given to the world. The supervision of the papers of a society by several members is perhaps the most important scientific work that any society can perform. Thirdly, there is the necessity of looking well after the funds, and managing them with economy and prudence.

Dr. Gray said it was almost forty years since Sir Joseph and himself spent some few hours together in the neighborhood of London, at the table of a then very venerable man, long since gone to his rest, Archibald Menzies, who was surgeon and naturalist of Vancouver's voyage. The interest in the venerable gentleman arose from the fact that he had been round the globe, and particularly had visited this part of it, and he was the first English naturalist, and almost the first naturalist, who set foot on this part of the continent. Partly through Professor Davidson's investigations he had been enabled to trace the footsteps of Menzies, whose name is merged in so many of our plants, the Madrona for instance. He had found that he had been in San Francisco, at the Presidio, and that he found his way as far as Santa Clara or San Jose, and it is very well known that he visited the point which was then the oldest settlement; that he landed and botanized at Monterey. It was with peculiar pleasure that they had followed in his footsteps at Monterey, and had been able to gather some plants and to see the withered remains of others that he first made known to the civilized world. Monterey is also the spot that some earlier naturalists visited, where the Spanish naturalists Mocino and Lesse collected plants, and also the Russian naturalists, Chamisso and Eschscholtz, whose names are familiar in all our gardens — household names in plants. The season of their visit to the coast had proved unpropitious on account of the great drouth, and what is still worse, from the ravages of the great flocks of sheep which have devastated the herbaceous vegetation of the Sierra. Fortunately the forests remain, the most important vegetation in respect to climate, geographical distribution, and utility. They had been very busy, and their work had not been in vain. They would be enabled to make some interesting comparisons, after visiting the Rocky Mountain region, and to settle, from observation in the field, some of the questions they had sought to settle in the laboratory and the conservatory. In conclusion, he referred to his visit five years ago, and the great pleasure it had given him to have as a companion his old friend Joseph Hooker.

Professor Hayden, in responding to the welcome, indicated the features of the geological survey in progress under his direction, and said he had long desired to make some comparison between the Sierra Nevada Mountains and the Rocky Mountains. It had always been his belief, although the belief had been corrected by his studies of the eastern slope, that there is a general geographical as well as geological unity in all the different ranges of mountains that compose our country. Some geologists have endeavored to give to the Sierra the name of the Cordilleras,

as a generic term, extending it to the Andes and to the eastern range, the Rocky Mountains. Other geologists have sought to make the Rocky Mountains the generic name, including in that range all the rest, and making the Sierra Nevada a branch. He was now inclined to think there is difference enough in the two ranges to regard them as separate, and perhaps almost independent ranges. One object of his visit was to examine the Yosemite Valley, and study the phenomena of its formation, and this he had been enabled to do. At some time he hoped to be in a position to study the geology of the coast carefully.

Professor Davidson added some remarks on the climatology of the coast with reference to ocean currents, and thereafter the Academy adjourned.

— The Princeton College student-expedition to the Rocky Mountains appeared to meet with good success. It started June 21st, and returned early in August, having accomplished a good deal in exploring the botany, zoölogy, palæontology, mineralogy, and topography of Colorado and the region about Fort Bridger in Wyoming. Nearly a thousand species of plants were collected. Of zoölogical specimens there were secured the heads of mountain sheep, elk, deer, antelope, bear, beaver, mountain lion, lynx, wild-cat, badger, etc., with complete skeletons of many animals of lesser size. A goodly collection of fossils was obtained in Colorado and in the Uintah Mountains.

— We have received Monographs of North American Rodentia, by Elliott Coues and Joel Araph Allen. Published as one of the quarto series of the United States Geological Survey of the Territories, F. V. Hayden in charge. Washington, 1877. It contains eleven monographs, five by Dr. Coues and six by Mr. Allen, with appendix; A Synoptical List of the Fossil Rodentia of North America, by J. A. Allen, and Appendix B.; Material for a Bibliography of North American Mammals, by Theodore Gill and Elliott Coues. The volume is carefully indexed, comprises 1091 pages, and contains fine plates illustrative of the skulls of the Muridæ. It may be truly said to be a monumental work upon a single order of mammals.

— One of the most valuable and useful works on zoölogy ever published and which is still passing through the press, is Bronn's Klassen und Ordnungen des Thier-reichs. Of the fifth volume, *Arthropoda*, Lieferung 24 has been the last published. The volume so far as it goes is accompanied by thirty-nine plates, and the text has been prepared by Professor Gerstaecker, the well known entomologist.

— A second edition of the Index Geological Map of Newfoundland, on the scale of twenty-five miles to an inch, has been published by Mr. Murray, whose report for 1876 has been issued.

— The Norwegian Expedition to the North Sea has met with fair success, especially in mapping the sea bottom off the coast of Norway, and ascertaining the limits of the extended barrier which keeps back the cold water coming from the depths of the Polar Sea.

— Sets of recent collections made by Dr. E. Palmer in Northern Arizona and Southeastern California in 1876, and Southern Utah and Nevada in 1877, may be obtained by application to Dr. C. C. Parry, Davenport, Iowa, or Professor Sereno Watson, Cambridge, Massachusetts. The sets number from three hundred to five hundred species, to be sold at $8.00 per hundred species.

— Professor Frederick Wahlgren, of the University of Lund, died in July, aged fifty-seven. Professor T. A. Conrad, the conchologist and palæontologist, died August 9th, aged seventy-four.

PROCEEDINGS OF SOCIETIES.

Boston Society of Natural History. — October 3. Mr. M. E. Wadsworth remarked on the so called tremolite of Newbury, Mass. Dr. T. M. Brewer read some notes on the stilt sandpiper, and Mr. S. H. Scudder exhibited a large collection of fossil insects from Colorado, made during the past summer, under the auspices of Hayden's U. S. Geological Survey of the Territories.

New York Academy of Sciences. — October 1. Mr. G. N. Lawrence presented descriptions of new West Indian birds, and Professor H. L. Fairchild made a communication on the structure of Lepidodendron and Sigillaria.

Appalachian Mountain Club. — October 10. Mr. S. H. Scudder described an ascent of the Sierra Blanca in Colorado.

SCIENTIFIC SERIALS.[1]

American Journal of Science and Arts. — On the Relations of the Geology of Vermont to that of Berkshire, by J. D. Dana. A Preliminary Catalogue of the Reptiles, Fishes, and Leptocardians of the Bermudas, with Descriptions of Four Species of Fishes believed to be New, by G. B. Goode.

Canadian Entomologist. — July. Remarks upon the Cynipidæ, by H. F. Bassett. August. — On the Preparatory Stages of Satyrus nephele, by W. H. Edwards.

Annals and Magazine of Natural History. — The Post-Tertiary Fossils procured in the late Arctic Expedition; with Notes on some of the Recent or Living Mollusca from the same Expedition, by J. G. Jeffreys.

The Geological Magazine. — September. Across Europe and Asia. Part III. The Middle Urals, by John Milne. Geology of the Isle of Man, by H. H. Howarth.

[1] The articles enumerated under this head will be for the most part selected.

Archiv für Naturgeschichte, Jahrgang 43, Heft 2. — Untersuchungen über den Kaumagen der Orthopteren, von K. F. Wilde. Grundzüge zur Systematik der Milben, von P. Kramer.

The Geographical Magazine. — October. The Seat of War (with a map of the seat of war in European Turkey, by Keith Johnston). M. Dupuis' Explorations in Tongkin and Yunnan. Delta of the Yangtsze River in China, by S. Mossman. A Description of the Island of Formosa, with some Remarks on its Past History, its Present Condition, and its Future Prospects, by J. Morrison. The Crozet Islands (South Indian Ocean), by L. Brine.

The Monthly Microscopical Journal. — October. New Diatoms from Honduras. Described by A. Grunow. With Notes by F. Kitton. Some Additional Remarks on the Measurement of the Angle of Aperture of Object Glasses, by F. H. Wenham.

Quarterly Journal of Microscopical Science. — October. The Doctrine of Contagium Vivum and its Application to Medicine, by W. Roberts. Résumé of Recent Contributions to our Knowledge of Fresh-Water Rhizopoda, Part IV. Rhizopoda Monothalamia Monostomata, compiled by W. Archer. Loxosoma, by Carl Vogt. On the Minute Structural Relations of the Red Blood Corpuscles, by A. Boettcher. Contribution to the Minute Anatomy of the Epidermis in Small-pox of Sheep, by E. Klein. Notes on the Embryology and Classification of the Animal Kingdom, comprising a Revision of Speculations Relative to the Origin and Significance of the Germ Layers, by E. R. Lankester.

The Geological Magazine. — October. Is Man Tertiary? The Antiquity of Man in the Roman Country, etc., by R. D. P. Mantovani. The Antiquity of Man, by J. R. Dakyns. Reversed Faults in Bedded Slates, by E. J. Hebert. The Geology of Sumatra, by M. R. D. M. Verbeek. The Migration of Species, by C. Callaway.

Annals and Magazine of Natural History. — October. Studies on Fossil Sponges, I. Hexactinellida, by K. A. Zittel. On some New and Little Known Spiders from the Arctic Regions, by O. P. Cambridge. On the Changes produced in the Silicious Skeletons of Certain Sponges by the Action of Caustic Potash, by W. J. Sollas. Capture of a Right Whale in the Mediterranean, by A. Doran. Notes on the Pearly Nautilus, by G. Bennett. On a New Insect Pest at Madeira, by T. V. Wollaston. Remarks on Professor E. Haeckel's Observations on *Wyville-thompsonia Wallichii* and *Squamulina scopula*, by H. J. Carter.

Popular Science Review. — October. The Volcanoes of the Haute Loire and the Ardêche, by W. S. Symonds. Flint Implements, by C. C. King. The Song of the Cicada, by J. C. Galton. Caves and their Occupants, illustrated by the Bone Caves of Creswell Crags, by J. M. Mello. Meteorites and the Origin of Life, by W. Flight.

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THE CHINESE LOESS PUZZLE.

BY PROFESSOR J. D. WHITNEY.

THE appearance of the first volume of Baron F. von Richthofen's magnificent work on China[1] furnishes us with a suitable opportunity to put before the readers of the NATURALIST a brief account of one of the most curiously puzzling geological phenomena which has ever been brought to the notice of the scientific world, — the distribution and mode of occurrence of the so-called loess deposits of Northern China. The term *loess* is one in popular use in the valley of the Rhine for a peculiar loamy material[2] which occurs over a considerable area between Constance and the Belgian lowlands, having in places a thickness of as much as one or two hundred feet, and which is generally admitted to have been a lacustrine deposit, formed when the Rhine was swollen by the melting of the great Alpine glaciers, which then extended much below their present level and covered a far greater area than they now do. Important as this formation is in that region, it sinks into insignificance when compared with what is presented by the Chinese deposits of similar character.

The Chinese loess, like that of the Rhine, is an earthy substance of a brownish-yellow color, so tender and little coherent that it can be easily rubbed to a powder between the fingers. It is chiefly made up of argillaceous materials, with a small proportion of carbonate of lime; and it has also mixed with it more or less fine sand, the grains of which are quite angular. This sand, however, is small in quantity as compared with the argillaceous

[1] China, Ergebnisse eigener Reisen und darauf gegründeter Studien, Erster Band, Einleitender Theil. Berlin, 1877.

[2] Loess is very nearly the equivalent of the English word loam. Perhaps the best way to define it would be to say that loam when developed enough to become a formation of geological importance, and not a mere surface deposit, is loess.

portion. The most striking facts with regard to this material in China are its wide-spread distribution and its enormous thickness, — facts which, taken in connection with its composition and structure, render its origin one of the most perplexing of geological problems.

First, as to its distribution. According to Richthofen, this formation is spread over a large part of the region drained by the Hwang-Ho or Yellow River, — a name derived from the color of the material which this great stream is continually carrying in suspension towards the Yellow Sea, in which name we again recognize the coloration given by the particles of the loess, which itself is called by the Chinese *hwang-tu* or yellow earth. For nearly a thousand miles from the borders of the great alluvial plain of Pechele, through the provinces of Shansi, Shensi, and Kansu, everywhere to the north of the Wei, which runs along the northern base of the range of the Tsing-ling-shan, the loess may be followed up to the very divide which separates the basin of the Hwang-Ho from the region destitute of drainage into the sea. Towards the north, it reaches almost to the edge of the Mongolian plateau. Furthermore, it may be observed in the province of Honan, along the south side of the most easterly outliers of the Kwenlun, filling a large portion of the middle part of the basin of the Han, covering large areas in Shantung, and reaching southwards in isolated patches as far as the Yangtse. The area over which the loess spreads itself almost continuously is as large as the whole of Germany; while it is found in more or less detached portions over an additional area nearly half as large as that empire.

From the known topographical character of the loess-covered region, it will be recognized at once that the formation in question occurs at very varying altitudes, or that it is distributed without regard to the elevation of the surface on which it rests. From near the level of the sea up to six thousand feet and more above it, this characteristic material lies, covering valley and mountain slope, absent only on the crests of some of the higher dividing ridges. This extraordinary range of vertical position has not been given to the loess by changes of level of the land since it was deposited, for Richthofen declares that it clearly results from his researches that the relative position of the higher and lower portions of the region in question has not been changed since the deposition of the loess; although he believes that, as a whole, its eastern border has been depressed in altitude, the

coast-line formerly extending farther out into the sea than it now does. So much for the horizontal and vertical distribution of the loess, and now some of its structural conditions may be noticed.

Two peculiarities strike the eye of the observer at once on examining the material in question: in the first place, the entire absence of any indications of stratification; and, second, the tendency which it everywhere exhibits to cleave or crack in vertical planes. These peculiarities, however, would not make such a strong impression on the mind of the geologist if it were not for the enormous thickness of the deposit, which is usually several hundred and in places reaches fifteen hundred or even two thousand feet. To see such a mass of material, not of igneous origin, destitute of any indication of stratification, is something entirely out of the ordinary experience of the geological observer. It would seem impossible that such a deposit could have been laid down except from water, and, if so, where are the lines of deposition, which never fail to make themselves visible in aqueous sediments? The problem, as will be seen, begins to present itself as a puzzle. But it may be asked, Is not this a deposit from water, in which, owing to some peculiar conditions, the lines of stratification have become obliterated? The answer to this is readily given in the negative, when on investigation it is found that this deposit, hundreds of feet in thickness, contains imbedded within its mass no fossil remains of marine or fresh-water origin, but only land shells — mostly those of snails — and occasional bones of land animals. It is evident, then, that this so-called loess is not similar in origin to that of the Rhine Valley, as indeed might easily have been inferred from its position at all elevations over plain and mountain side; but that it is a subaerial deposit.

Apart from theoretical considerations of origin, which make this loess formation so interesting, there are other circumstances resulting from its mode of occurrence, which bear on the daily life of the people inhabiting these loess-covered districts, and so connect themselves with their agriculture, their roads, and their means of military defense as to be abundantly striking, even to the observer who cares nothing for geological problems, and to whom the absence of lines of stratification would not appear as a noticeable fact. The peculiar type of scenery which these great areas, covered by such a thickness of soft, easily eroded material, present could not fail to impress itself on the mind of the most careless observer. And we find that the main features of the landscape in the loess districts are closely connected in their ori-

gin with the tendency which this material possesses — as already noticed — to divide into masses separated by vertical planes; a peculiarity which is not properly cleavage, neither is it exactly what geologists call jointing, but something near akin to it. As a result of this tendency, we find that the rivers which run through the loess-covered districts are bordered by absolutely vertical walls of this material, sometimes hundreds of feet in height. Given the elements of great thickness of the deposits, extreme facility of erosion due to the softness of the mass, and the tendency to vertical cleavage, and it can easily be imagined that the resulting forms left from the action of erosive agencies must be extremely complex and peculiar. Indeed, as described by Richthofen, the loess-covered region is certainly one of the most curious portions of the earth's surface. It somewhat resembles the Colorado plateau, in being deeply and intricately furrowed by drainage channels of great depth, and proportionately very narrow. In the Colorado region, however, the walls of the cañons, as these gorges are there called, are never vertical, though usually quite steep, and the material on which the water exercises its erosive power has a greater variety of texture and color than that offered by the loess, which is remarkably homogeneous from top to bottom. The difficulty of traversing such a region, or even of engineering roads through it, can readily be imagined. It is not so much of a task to keep on one main divide between two systems of gorges; but to go across the country in any fixed direction is almost an impossibility. Tunnels and spiral stairways in the mass of the loess must often be resorted to. In short, the configuration of the surface is, as Richthofen remarks, most fantastic and curious. "Wide chasms are surrounded by castles, towers, peaks, and needles, all made up of yellow earth, between which gorges and chasms radiate labyrinthically upwards into the walls of solid ground around. High up on a rock of earth, steeper than any rock of stone, stands the temple of the village, or a small fortress which affords the villagers a safe retreat in times of danger. The only access to such a place is by a spiral stairway dug out within the mass of the bluff itself. In this yellow defile there are innumerable nooks and recesses, often enlivened by thousands of people, who dwell in caves dug out in the loess.[1]"

Millions of human beings live in habitations excavated in this

[1] Richthofen, Letter on the Provinces of Chili, Shansi, Shensi, and Sz'-chwan. Shanghai, 1872.

material. These dwellings vary in character from mere holes in the ground to commodious mansions. The largest houses for the entertainment of travelers are sometimes excavated to a distance of two hundred feet into the ground, with corresponding breadth and height, so that numerous guests, with their vehicles and animals, can be housed with comfort, small side apartments being cut out adjacent to the large one for sleeping quarters. The walls of these extraordinary dwellings are lined with cement made from the calcareous nodules which the loess often contains; this arrangement tends to cleanliness and durability, and dwellings thus protected sometimes last for hundreds of years, being warm in winter and cool in summer. It must be a most curious experience to travel over the surface of a highly cultivated loess district, and to see no signs of any inhabitants, until one comes to some point where the vertical wall of yellow earth is exposed to view, in and out of the holes in which the people are seen swarming like bees around a bee-hive. To the traveler looking down from an adjacent elevation on to one of the loess basins, the surface seems uniform in character with a gently descending slope, easily accessible and green with vegetation; from the bottom of one of the gorges, on the other hand, only the bare, vertical loess walls are visible, while the whole mass is found to be intersected with a labyrinth of deep and, from the general level, inaccessible gorges.

Such are some of the more striking peculiarities of the loess formation. But, besides its tendency to vertical cleavage, it exhibits a more or less complete arrangement in thick layers, and this has been taken by some observers for a real stratification, which, however, as Richthofen considers that he has clearly established, it is not. This pseudo-stratification depends for its existence on horizontal lines of calcareous concretions, like what we call clay-stones, the *Loessmännchen* of the dwellers on the Rhine, and which the Chinese call by a name which means "stone ginger," from the resemblance of these concretionary forms to the roots of the ginger plant. That these loessmännchen have been formed in the loess by infiltration along the lines of cleavage and resultant chemical action on calcareous matter occurring in large quantity along certain planes, and that they are not the product of anything like deposition from water, is clearly shown by their vertical position in the material in which they are found; had they been swept into their places by a current of water, they must have been laid upon their flat surfaces. These imperfectly

formed concretionary layers exercise an important influence in determining a terrace-like form of the sides of the gorges worn down in the loess, which often rise in a succession of steps, having this peculiarity: that there is little or no talus or sloping pile of débris along the line where the vertical and horizontal surfaces meet. The natural tendency to this condition of things is assisted in its development by the labors of those who cultivate the soil, and for whose advantage it is to gain as much flat surface as possible.

The first person to notice and describe these remarkable deposits was Professor Pumpelly, who, in 1864, journeyed over a portion of the loess-covered districts lying along the southern border of Mongolia. His observation, however, did not, by any means, extend over so wide an area as those of Richthofen, and his theory of the origin of the loess appears to be insufficiently supported by the facts which a much larger and more exhaustive investigation of the country brought to light; still, it must be admitted that there are difficulties which no theory seems able fully to overcome. Professor Pumpelly considered the loess, which he describes under the name of "terrace deposit," as a lacustrine formation, each of the basins in which this material occurs having been once the bed of a lake, a series of large bodies of fresh water being assumed as formerly extending along the course of the Hwang-Ho, which did not then occupy its present position, but ran in a pretty direct line, connecting the different basins, from Ning-hia-fu to Peking. This theory, therefore, demands that there should have been a considerable diminution in the quantity of water formerly covering the region in question. It seems the most plausible one at first sight, however, and other observers — as for instance Kingsmill — have not hesitated to adopt and defend it.

The difficulties which this theory presents seem, as developed by Richthofen, almost, if not quite, insurmountable. The main arguments urged against Pumpelly's theory will be readily inferred from what has been stated in the preceding paragraphs. The absence of indications of stratification, and the constant presence in the material of land instead of fresh-water shells, and of bones of land animals, are facts which it seems impossible to set aside, since they result from prolonged observations made by a most skillful geologist. Besides, the loess indicates by its structure the growth on its surface during deposition of an abundant vegetation. The plants themselves — grasses, chiefly — are

no longer there; but the constant occurrence of innumerable delicate, elongated cavities, occupying a nearly vertical position, ramifying and inosculating at very acute angles, just as do the rootlets of plants, shows their former presence. It is to this peculiarity that the tendency to vertical cleavage, which is so conspicuously manifested in the loess, is largely due.

There is a greater difficulty still, if possible, in the way of the adoption of the lacustrine origin of these deposits. As Richthofen declares with the utmost confidence, based on a thorough examination of the region, the loess everywhere exhibits itself as a deposit which was not laid down until after the surface of the country where it occurs had assumed its present configuration. The orographic conditions are not such as, by any possibility, could allow of the formation of a connected series of lake-like expansions of the Hwang-Ho, as is demanded by Professor Pumpelly's theory.

Richthofen, therefore, unhesitatingly declares himself in favor of a subaerial origin of the loess; and he endeavors to account for the accumulation of this enormous mass of material in the following manner. In the first place, and as a necessity of the proposed theory, the district of the loess was once destitute of outward drainage, consisting, in fact, of a number of closed basins, such as are still found occurring in the adjacent region to the west in Central Asia. These closed basins were prairies, and the loess is "the collective residue of uncountable generations of herbaceous plants." It is the inorganic residuum which has accumulated during an immense lapse of time as the result of the decay of a vigorous prairie growth, ever renewing itself on the surface of the slowly accumulating deposit. But how is the increase of the deposit provided for by the theory? Unless there be some source supplying material from without, there can evidently be no gain in thickness, however many generations of plants succeed each other. The necessary addition of mineral matter Richthofen considers to have been brought into these basins by two agencies, the rain and the wind, and the latter especially plays an important part in this theory. Each basin being surrounded by a rim of rocks, constantly undergoing decomposition, the particles thus set free were either swept down the mountain sides towards the central area by rain, or blown thither by air currents, and once entangled among the vegetation could not be carried farther.

The facts being assumed to be as Richthofen states them, it

would appear that no other theory than this can be adopted for their explanation. A marine origin is rendered impossible by the absence of marine fossils, the constant presence of land shells and bones of land animals, as also by the absence of stratification and the very great differences of level at which the formation rests. The same arguments apply to the theory of a lacustrine origin, except that the one last mentioned would not present insuperable difficulties, or at least not any greater ones than those which the adoption of Richthofen's views implies. Either theory seems to need for its support changes of climate and a certain amount of alteration in the configuration of the surface. If the loess were deposited in closed basins, these are now opened to the sea and drained by the Hwang-Ho. The areas once separated from each other are at present connected; the deposits they inclosed are now being swept away to the sea. It is impossible to account for this changed condition of things without admitting a considerable increase in the amount of precipitation over the region in question, and it is not easy to see how a complete drainage system could have been established without the formation of a certain number of lakes, nor why these should all have disappeared so completely. According to the lacustrine theory, on the other hand, the precipitation is now less than it formerly was; the mighty lakes have shrunk and disappeared, the Hwang-Ho is but the remnant of what was once a much larger stream. What change of level in the area thus drained would be required to fit this theory it seems difficult to make out. The appearance, in a future volume of Richthofen's great work, of the details of the cartography and geology of the region in question will, no doubt, be of much assistance in enabling one to form a clearer opinion of these matters. The interesting chapter in the volume already published, entitled Formation and Remodeling (Bildung und Umbildung) of the Salt Steppes of Central Asia, in which subjects closely connected with the question of the mode of formation of the loess are discussed at very considerable length, cannot at present be entered upon, for want of space. Its consideration may be taken up at a future time, when it will be found that it has important bearings on certain points closely related to our own surface geology, and which have not yet received anything like the attention which they deserve at the hands of our geological observers. It is sufficient, for the present, to have given the readers of the NATURALIST an idea of one among the many interesting topics treated in Richthofen's work. It should

be added, however, that the contents of the only volume as yet published refer chiefly to the historical development of geographical discovery in China and Central Asia, forming by far the most copious and thoroughly digested summary of facts ever as yet presented relating to this interesting but difficult subject.

THE COLORS OF ANIMALS AND PLANTS.[1]

BY ALFRED RUSSEL WALLACE.

I. THE COLORS OF ANIMALS.

Theory of Sexual Colors. — In Mr. Darwin's celebrated work, The Descent of Man and Selection in Relation to Sex, he has treated of sexual color in combination with other sexual characters, and has arrived at the conclusion that all, or almost all, the colors of the higher animals (including among these insects and all vertebrates) are due to voluntary sexual selection ; and that diversity of color in the sexes is due, primarily, to the transmission of color-variations either to one sex only, or to both sexes, the difference depending on some unknown law, and not being due to natural selection.

I have long held this portion of Mr. Darwin's theory to be erroneous, and have argued that the primary cause of sexual diversity of color was the need of protection, repressing in the female those bright colors which are nominally produced in both sexes by general laws; and I have attempted to explain many of the more difficult cases on this principle (A Theory of Birds' Nests, in Contributions, etc., page 231). As I have since given much thought to this subject, and have arrived at some views which appear to me to be of considerable importance, it will be well to sketch briefly the theory I now hold, and afterward show its application to some of the detailed cases adduced in Mr Darwin's work.

The very frequent superiority of the male bird or insect in brightness or intensity of color, even when the general tints and coloration are the same, now seems to me to be due to the greater vigor and activity and the higher vitality of the male. The colors of an animal usually fade during disease or weakness, while robust health and vigor add to their intensity. This intensity of coloration is most manifest in the male during the breeding-season, when the vitality is at a maximum. It is also very manifest

[1] From Macmillan's Magazine. Concluded from page 662.

in those cases in which the male is smaller than the female, as in the hawks and in most butterflies and moths. The same phenomena occur, though in a less marked degree, among mammalia. Whenever there is a difference of color between the sexes the male is the darker or more strongly marked, and difference of intensity is most visible during the breeding season (Descent of Man, page 533). Numerous cases among domestic animals also prove that there is an inherent tendency in the male to special developments of dermal appendages and color, quite independently of sexual or any other form of selection. Thus, "the hump on the male zebu cattle of India, the tail of fat-tailed rams, the arched outline of the forehead in the males of several breeds of sheep, and the mane, the long hairs on the hind-legs, and the dewlap of the male of the Berbura goat," are all adduced by Mr. Darwin as instances of characters peculiar to the male, yet not derived from any parent ancestral form. Among domestic pigeons the character of the different breeds is often most strongly manifested in the male birds; the wattle of the carriers and the eye-wattles of the barbs are largest in the males, and male pouters distend their crops to a much greater extent than do the females, and the cock fantails often have a greater number of tail-feathers than the females. There are also some varieties of pigeons of which the males are striped or spotted with black, while the females are never so spotted (Animals and Plants under Domestication, i., 161); yet in the parent stock of these pigeons there are no differences between the sexes either of plumage or color, and artificial selection has not been applied to produce them.

The greater intensity of coloration in the male — which may be termed the normal sexual difference — would be further developed by the combats of the males for the possession of the females. The most vigorous and energetic usually being able to rear most offspring, intensity of color, if dependent on or correlated with vigor, would tend to increase. But as differences of color depend upon minute chemical or structural differences in the organism, increasing vigor acting unequally on different portions of the integument, and often producing at the same time abnormal developments of hair, horns, scales, feathers, etc., would almost necessarily lead also to variable distribution of color, and thus to the production of new tints and markings. These acquired colors would, as Mr. Darwin has shown, be transmitted to both sexes or to one only, according as they first ap-

peared at an early age, or in adults of one sex, and thus we may account for some of the most marked differences in this respect. With the exception of butterflies, the sexes are almost alike in the great majority of insects. The same is the case in mammals and reptiles, while the chief departure from the rule occurs in birds, though even here in very many cases the law of sexual likeness prevails. But in all cases where the increasing development of color became disadvantageous to the female, it would be checked by natural selection, and thus produce those numerous instances of protective coloring in the female only which occur in these two groups of animals.

There is also, I believe, a very important purpose and use of the varied colors of the higher animals, in the facility it affords for recognition by the sexes or by the young of the same species; and it is this use which probably fixes and determines the coloration in many cases. When differences of size and form are very slight, color affords the only means of recognition at a distance or while in motion, and such a distinctive character must therefore be of especial value to flying insects which are continually in motion, and encounter each other, as it were, by accident. This view offers us an explanation of the curious fact that among butterflies the females of closely-allied species in the same locality sometimes differ considerably, while the males are much alike; for as the males are the swiftest and the highest fliers and seek the females, it would evidently be advantageous for them to be able to recognize their true partners at some distance off. This peculiarity occurs with many species of *Papilio*, *Diadema*, *Adolias*, and *Colias*. In birds such marked differences of color are not required, owing to their higher organization and more perfect senses, which render recognition easy by means of a combination of very slight differential characters. This principle may, perhaps, however, account for some anomalies of coloration among the higher animals. Thus, Mr. Darwin, while admitting that the hare and the rabbit are colored protectively, remarks that the latter, while running to its burrow, is made conspicuous to the sportsman, and no doubt to all beasts of prey, by its upturned, white tail. But this very conspicuousness while running away may be useful as a signal and guide to the young, who are thus enabled to escape danger by following the older rabbits, directly and without hesitation, to the safety of the burrow; and this may be the more important from the semi-nocturnal habits of the animal. If this explanation is correct, and it certainly seems prob-

able, it may serve as a warning of how impossible it is, without exact knowledge of the habits of an animal and a full consideration of all the circumstances, to decide that any particular coloration cannot be protective or in any way useful. Mr. Darwin himself is not free from such assumptions. Thus, he says: "The zebra is conspicuously striped, and stripes cannot afford any protection on the open plains of South Africa." But the zebra is a very swift animal, and, when in herds, by no means void of means of defense. The stripes, therefore, *may* be of use by enabling stragglers to distinguish their fellows at a distance, and they *may* be even protective when the animal is at rest among herbage — the only time when it would need protective coloring. Until the habits of the zebra have been observed with special reference to this point, it is surely somewhat hasty to declare that the stripes "cannot afford any protection."

The wonderful display and endless variety of color in which butterflies and birds so far exceed all other animals seem primarily due to the excessive development and endless variations of the integumentary structures. No insects have such widely-expanded wings in proportion to their bodies as butterflies and moths; in none do the wings vary so much in size and form, and in none are they clothed with such a beautiful and highly-organized coating of scales. According to the general principles of the production of color already explained, these long-continued expansions of membranes and developments of surface-structures must have led to numerous color-changes, which have been sometimes checked, sometimes fixed and utilized, sometimes intensified, by natural selection, according to the needs of the animal. In birds, too, we have the wonderful clothing of plumage — the most highly-organized, the most varied, and the most expanded of all dermal appendages. The endless processes of growth and change during the development of feathers, and the enormous extent of this delicately-organized surface, must have been highly favorable to the production of varied color-effects, which, when not injurious, have been merely fixed for purposes of specific identification, but have often been modified or suppressed whenever different tints were needed for purposes of protection.

To voluntary sexual selection, that is, the actual choice by the females of the more brilliantly-colored males, I believe very little if any effect is directly due. It is undoubtedly proved that in birds the females do sometimes exert a choice; but the evidence of this fact collected by Mr. Darwin (Descent of Man, chapter

xiv.) does not prove that color determines that choice, while much of the strongest evidence is directly opposed to this view. All the facts appear to be consistent with the choice depending on a variety of male characteristics, with some of which color is often correlated. Thus it is the opinion of some of the best observers that vigor and liveliness are most attractive, and these are, no doubt, usually associated with intensity of color. Again, the display of the various ornamental appendages of the male during courtship may be attractive; but these appendages, with their bright colors or shaded patterns, are due probably to general laws of growth and to that superabundant vitality which we have seen to be a cause of color. But there are many considerations which seem to show that the possession of these ornamental appendages and bright colors in the male is not an important character functionally, and that it has not been produced by the action of voluntary sexual selection. Amid the copious mass of facts and opinions collected by Mr. Darwin as to the display of color and ornaments by the male birds, there is a total absence of any evidence that the females admire or even notice this display. The hen, the turkey, and the pea-fowl, go on feeding while the male is displaying his finery, and there is reason to believe that it is his persistency and energy rather than his beauty which wins the day. Again, evidence collected by Mr. Darwin himself proves that each bird finds a mate under any circumstances. He gives a number of cases of one of a pair of birds being shot, and the survivor being always found paired again almost immediately. This is sufficiently explained on the assumption that the destruction of birds by various causes is continually leaving widows and widowers in nearly equal proportions, and thus each one finds a fresh mate; and it leads to the conclusion that permanently-unpaired birds are very scarce; so that, speaking broadly, every bird finds a mate and breeds. But this would almost or quite neutralize any effect of sexual selection of color or ornament, since the less highly-colored birds would be at no disadvantage as regards leaving healthy offspring. If, however, heightened color is correlated with health and vigor, and these healthy and vigorous birds provide best for their young, and leave offspring which, being equally healthy and vigorous, can best provide for themselves, then natural selection becomes a preserver and intensifier of color. Another most important consideration is, that male butterflies rival or even excel the most gorgeous male birds in bright colors and elegant patterns; and

among these there is literally not one particle of evidence that the female is influenced by color, or even that she has any power of choice, while there is much direct evidence to the contrary (Descent of Man, page 318). The weakness of the evidence for sexual selection among these insects is so palpable that Mr. Darwin is obliged to supplement it by the singularly inconclusive argument that "unless the females prefer one male to another, the pairing must be left to mere chance, and this does not appear probable" (*loc. cit.*, page 317). But he has just said, "The males sometimes fight together in rivalry, and many may be seen pursuing or crowding round the same female;" while in the case of the silk-moths, "the females appear not to evince the least choice in regard to their partners." Surely, the plain inference from all this is, that males fight and struggle for the almost passive female, and that the most vigorous and energetic, the strongest-winged or the most persevering, wins her. How can there be chance in this? Natural selection would here act, as in birds, in perpetuating the strongest and most vigorous males, and as these would usually be the more highly-colored of their race, the same results would be produced as regards the intensification and variation of color in the one case as in the other.

Let us now see how these principles will apply to some of the cases adduced by Mr. Darwin in support of his theory of voluntary sexual selection.

In Descent of Man, second edition, pp. 307–316, we find an elaborate account of the various modes of coloring of butterflies and moths, proving that the colored parts are always more or less displayed, and that they have some evident relation to an observer. Mr. Darwin then says: "From the several foregoing facts it is impossible to admit that the brilliant colors of butterflies, and of some few moths, have commonly been acquired for the sake of protection. We have seen that their colors and elegant patterns are arranged and exhibited as if for display. Hence, I am led to believe that the females prefer or are most excited by the more brilliant males; for on any other supposition the males would, as far as we can see, be ornamented to no purpose" (*loc. cit.*, p. 316). I am not aware that any one has ever maintained that the brilliant colors of butterflies have "commonly been acquired for the sake of protection," yet Mr. Darwin has himself referred to cases in which the brilliant color is so placed as to serve for protection; as, for example, the eye-spots on the hind-wings of moths, which are pierced by birds, and

so save the vital parts of the insect, while the bright patch on the orange-tip butterflies, which Mr. Darwin denies are protective, may serve the same purpose. It is, in fact, somewhat remarkable how very generally the black spots, ocelli, or bright patches of color, are on the tips, margins, or disks of the wings; and, as the insects are necessarily visible while flying, and this is the time when they are most subject to attacks by insectivorous birds, the position of the more conspicuous parts at some distance from the body may be a real protection to them. Again, Mr. Darwin admits that the white color of the male ghost-moth may render it more easily seen by the female while flying about in the dusk, and if to this we add that it will be also more readily distinguished from allied species, we have a reason for diverse ornamentation in these insects quite sufficient to account for most of the facts, without believing in the selection of brilliant males by the females, for which there is not a particle of evidence. The facts given to show that butterflies and other insects can distinguish colors, and are attracted by colors similar to their own, are quite consistent with the view that color, which continually tends to appear, is utilized for purposes of identification and distinction, when not required to be modified or suppressed for purposes of protection. The cases of the females of some species of *Thecla*, *Callidryas*, *Colias*, and *Hipparchia*, which have more conspicuous markings than the male, may be due to several causes: to obtain greater distinction from other species, for protection from birds, as in the case of the yellow-under-wing moths, while sometimes—as in *Hipparchia*—the lower intensity of coloring in the female may lead to more contrasted markings. Mr. Darwin thinks that here the males have selected the more beautiful females, although one chief fact in support of his theory of voluntary sexual selection is, that throughout the whole animal kingdom the males are usually so ardent that they will accept any female, while the females are coy, and choose the handsomest males, whence it is believed the general brilliancy of males as compared with females has arisen.

Perhaps the most curious cases of sexual difference of color are those in which the female is very much more gayly colored than the male. This occurs most strikingly in some species of *Pieris* in South America, and of *Diadema* in the Malay islands, and in both cases the females resemble the uneatable Danaidæ and Heliconidæ, and thus gain a protection. In the case of *Pieris pyrrha*, *P. malenka*, and *P. lorena*, the males are plain white

and black, while the females are orange, yellow, and black, and so banded and spotted as exactly to resemble species of Heliconidæ. Mr. Darwin admits that these females have acquired these colors as a protection; but as there is no apparent cause for the strict limitation of the color to the female, he believes that it has been kept down in the male by its being *unattractive* to her. This appears to me to be a supposition opposed to the whole theory of sexual selection itself. For this theory is, that minute variations of color in the male are *attractive* to the female, have always been selected, and that thus the brilliant male colors have been produced. But in this case he thinks that the female butterfly had a constant aversion to every trace of color, even when we must suppose it was constantly recurring during the successive variations which resulted in such a marvelous change in herself. But if we consider the fact that the females frequent the forests where the Heliconidæ abound, while the males fly much in the open, and assemble in great numbers with other white and yellow butterflies on the banks of rivers, may it not be possible that the appearance of orange stripes or patches would be as injurious to the male as it is useful to the female, by making him a more easy mark for insectivorous birds among his white companions? This seems a more probable supposition than the altogether hypothetical choice of the female, sometimes exercised in favor of and sometimes against every new variety of color in her partner.

The full and interesting account given by Mr. Darwin of the colors and habits of male and female birds (Descent of Man, chapters xiii. and xiv.) proves that in most, if not in all, cases the male birds fully display their ornamental plumage before the females, and in rivalry with each other; but on the essential point of whether the female's choice is determined by minute differences in these ornaments or in their colors, there appears to be an entire absence of evidence. In the section on Preference for Particular Males by the Females, the facts quoted show indifference to color, except that some color similar to their own seems to be preferred. But in the case of the hen-canary, who chose a greenfinch in preference to either chaffinch or goldfinch, gay colors had evidently no preponderating attraction. There is some evidence adduced that female birds may, and probably do, choose their mates, but none whatever that the choice is determined by difference of color; and no less than three eminent breeders informed Mr. Darwin that they "did not believe that

the females prefer certain males on account of the beauty of their plumage." Again, Mr. Darwin himself says, "As a general rule, color appears to have little influence on the pairing of pigeons." The oft-quoted case of Sir R. Heron's peahens, which preferred an "old pied cock" to those normally colored, is a very unfortunate one, because pied birds are just those that are not favored in a state of nature, or the breeds of wild birds would become as varied and mottled as our domestic varieties. If such irregular fancies were not rare exceptions, the production of definite colors and patterns by the choice of the female birds, or in any other way, would be impossible.

We now come to such wonderful developments of plumage and color as are exhibited by the peacock and the Argus pheasant; and I may here mention that it was the latter bird, as fully discussed by Mr. Darwin, which first shook my belief in "sexual," or more properly "female," selection. The long series of gradations by which the beautifully-shaded ocelli on the secondary wing feathers of this bird have been produced are clearly traced out, the result being a set of markings so exquisitely shaded as to represent "balls lying loose within sockets," — purely artificial objects of which these birds could have no possible knowledge. That this result should have been attained through thousands and tens of thousands of female birds, all preferring those males whose markings varied slightly in this one direction, this uniformity of choice continuing through thousands and tens of thousands of generations, is to me absolutely incredible. And when, further, we remember that those which did not so vary would also, according to all the evidence, find mates and leave offspring, the actual result seems quite impossible of attainment by such means.

Without pretending to solve completely so difficult a problem, I would point out a circumstance which seems to afford a clew. It is that the most highly colored and most richly varied markings occur on those parts of the plumage which have undergone the greatest modification, or have acquired the most abnormal development. In the peacock the tail coverts are enormously developed, and the "eyes" are situated on the greatly dilated ends. In the birds-of-paradise, breast, or neck, or head, or tail feathers are greatly developed and highly colored. The hackles of the cock and the scaly breasts of humming-birds are similar developments; while in the Argus pheasant the secondary quills are so enormously lengthened and broadened as to have become almost useless for flight. Now, it is easily conceivable that, dur-

ing this process of development, inequalities in the distribution of color may have arisen in different parts of the same feather, and that spots and bands may thus have become broadened out into shaded spots or ocelli, in the way indicated by Mr. Darwin, much as the spots and rings on a soap-bubble increase with increasing tenuity. This is the more probable, as in domestic fowls varieties tend to become symmetrical, quite independently of sexual selection. (Descent of Man, page 424.)

If, now, we accept the evidence of Mr. Darwin's most trustworthy correspondents that the choice of the female, so far as she exerts any, falls upon the "most vigorous, defiant, and mettlesome male," and if we further believe, what is certainly the case, that these are, as a rule, the most brightly colored and adorned with the finest developments of plumage, we have a real and not a hypothetical cause at work. For these most healthy, vigorous, and beautiful males will have the choice of the finest and most healthy females, will have the most numerous and healthy families, and will be able best to protect and rear those families. Natural selection, and what may be termed male selection, will tend to give them the advantage in the struggle for existence, and thus the fullest plumage and the finest colors will be transmitted, and tend to advance in each succeeding generation.

There remains, however, what Mr. Darwin evidently considers his strongest argument, the display by the male of each species of its peculiar beauties of plumage and color. We have here, no doubt, a very remarkable and very interesting fact; but this, too, may be explained by general principles, quite independent of any choice or volition of the female bird. During pairing-time the male bird is in a state of great excitement, and full of exuberant energy. Even unornamented birds flutter their wings or spread them out, erect their tails or crests, and thus give vent to the nervous excitability with which they are overcharged. It is not improbable that crests and other erectile feathers may be primarily of use in frightening away enemies, since they are generally erected when angry or during combat. Those individuals who were most pugnacious and defiant, and who brought these erectile plumes most frequently and most powerfully into action, would tend to increase them by use, and to leave them further developed in some of their descendants. If, in the course of this development, color appeared, we have every reason to believe it would be most vivid in these most pugnacious and energetic individuals; and as these would always have the advantage in the

rivalry for mates (to which advantage the excess of color and plumage might sometimes conduce), there seems nothing to prevent a progressive development of these ornaments in *all dominant races*, that is, wherever there was such a surplus of vitality and such complete adaptation to conditions that the inconvenience or danger produced by them was so comparatively small as not to affect the superiority of the race over its nearest allies. If, then, those portions of the plumage which were originally erected and displayed became developed and colored, the actual display, under the influence of jealousy or sexual excitement, becomes intelligible. The males, in their rivalry with each other, would see what plumes were most effective, and each would endeavor to excel his enemy as far as voluntary exertion could effect it, just as they endeavor to rival each other in song, even sometimes to the point of causing their own destruction.

There is also a general argument against Mr. Darwin's views on this question, founded on the nature and potency of "natural" as opposed to "sexual" selection, which appears to me to be itself almost conclusive of the whole matter at issue. Natural selection, or the survival of the fittest, acts perpetually and on an enormous scale. Taking the offspring of each pair of birds as, on the average, only six annually, one third of these at most will be preserved, while the two thirds which are least fitted will die. At intervals of a few years, whenever unfavorable conditions occur, five sixths, nine tenths, or even a greater proportion of the whole yearly production are weeded out, leaving only the most perfect and best adapted to survive. Now, unless these survivors are on the whole the most ornamental, this rigid selective power must neutralize and destroy any influence that may be exerted by female selection. For the utmost that can be claimed for this is that a small fraction of the least ornamented do not obtain mates, while a few of the most ornamented may leave more than the average number of offspring. Unless, therefore, there is the strictest correlation between ornament and general perfection, the former can have no permanent advantage; and if there is (as I maintain) such a correlation, then the sexual selection of ornament, for which there is little or no evidence, becomes needless, because natural selection, which is an admitted *vera causa*, will itself produce all the results. In the case of butterflies the argument becomes even stronger, because the fertility is so much greater, and the weeding out of the unfit takes place, to a great extent, in the egg and larva state. Unless the eggs and larvæ

which escaped to produce the next generation were those which would produce the more highly colored butterflies, it is difficult to perceive how the slight preponderance of color sometimes selected by the females should not be wholly neutralized by the extremely rigid selection for other qualities to which the offspring in every stage are exposed. The only way in which we can account for the observed facts is by the supposition that color and ornament are strictly correlated with health, vigor, and general fitness to survive. We have shown that there is reason to believe that this is the case, and, if so, voluntary sexual selection becomes as unnecessary as it would certainly be ineffective.

There is one other very curious case of sexual coloring among birds: that, namely, in which the female is decidedly brighter or more strongly marked than the male, as in the fighting quails (*Turnix*), painted snipe (*Rhynchæa*), two species of phalarope (*Phalaropus*), and the common cassowary (*Casuarius galeatus*). In all these cases, it is known that the males take charge of and incubate the eggs, while the females are almost always larger and more pugnacious. In my Theory of Birds' Nests [1] I imputed this difference of color to the greater need for protection by the male bird while incubating, to which Mr. Darwin has objected that the difference is not sufficient, and is not always so distributed as to be most effective for this purpose; and he believes that it is due to reversed sexual selection, that is, to the female taking the usual *rôle* of the male, and being chosen for her brighter tints. We have already seen reason for rejecting this latter theory in every case, and I also admit that my theory of protection is, in this case, only partially, if at all, applicable. But the general theory of intensity of color being due to general vital energy is quite applicable; and the fact that the superiority of the female in this respect is quite exceptional, and is therefore probably not of very ancient date in any one case, will account for the difference of color thus produced being always comparatively slight.

Theory of Typical Colors. — The remaining kinds of animal colors — those which can neither be classed as protective, warning, nor sexual — are for the most part readily explained on the general principles of the development of color which we have now laid down. It is a most suggestive fact that, in cases where color is required only as a warning, as among the uneatable caterpillars, we find, not one or two glaring tints only, but every kind of color disposed in elegant patterns, and exhibiting almost

[1] Natural Selection, page 251.

as much variety and beauty as among insects and birds. Yet here, not only is sexual selection out of the question, but the need for recognition and identification by others of the same species seems equally unnecessary. We can then only impute this variety to the normal production of color in organic forms, when fully exposed to light and air and undergoing great and rapid developmental modification. Among more perfect animals, where the need for recognition has been added, we find intensity and variety of color at its highest pitch among the South American butterflies of the families Heliconidæ and Danaidæ, as well as among the Nymphalidæ and Erycinidæ, many of which obtain the necessary protection in other ways. Among birds, also, wherever the habits are such that no special protection is needed for the females, and where the species frequent the depths of tropical forests, and are thus naturally protected from the swoop of birds of prey, we find almost equally intense coloration, as in the trogons, barbets, and gapers.

Of the mode of action of the general principles of color development among animals, we have an excellent example in the humming-birds. Of all birds these are at once the smallest, the most active, and the fullest of vital energy. When poised in the air, their wings are invisible, owing to the rapidity of their motion, and when startled they dart away with the rapidity of a flash of light. Such active creatures would not be an easy prey to any rapacious bird; and if one at length was captured, the morsel obtained would hardly repay the labor. We may be sure, therefore, that they are practically unmolested. The immense variety they exhibit in structure, plumage, and color indicates a high antiquity for the race, while their general abundance in individuals shows that they are a dominant group, well adapted to all the conditions of their existence. Here we find everything necessary for the development of color and accessory plumes. The surplus vital energy shown in their combats and excessive activity has expended itself in ever-increasing developments of plumage and greater and greater intensity of color, regulated only by the need for specific identification, which would be especially required in such small and mobile creatures. Thus may be explained those remarkable differences of color between closely-allied species, one having a crest like the topaz, while in another it resembles the sapphire. The more vivid colors and more developed plumage of the males, I am now inclined to think, may be wholly due to their greater vital energy and to

those general laws which lead to such superior developments even in domestic breeds; but in some cases the need of protection by the female while incubating, to which I formerly imputed the whole phenomenon, may have suppressed a portion of the ornament which she would otherwise have attained.

Another real though as yet inexplicable cause of diversity of color is to be found in the influence of locality. It is observed that species of totally distinct groups are colored alike in one district, while in another district the allied species all undergo the same change of color. Cases of this kind have been adduced by Mr. Bates, by Mr. Darwin, and by myself, and I have collected all the more curious and important examples in my Address to the Biological Section of the British Association at Glasgow in 1876. The most probable cause for these simultaneous variations would seem to be the presence of peculiar elements or chemical compounds in the soil, the water, or the atmosphere, or of special organic substances in the vegetation; and a wide field is thus offered for chemical investigation in connection with this interesting subject. Yet, however we may explain it, the fact remains of the same vivid colors in definite patterns being produced in quite unrelated groups, which only agree, so far as we yet know, in inhabiting the same locality.

Let us now sum up the conclusion at which we have arrived as to the various modes in which color is produced or modified in the animal kingdom.

The various causes of color in the animal world are molecular and chemical change of the substance of their integuments, or the action on it of heat, light, or moisture. It is also produced by interference of light in superposed transparent lamellæ, or by excessively fine surface striæ. These elementary conditions for the production of color are found everywhere in the surface structures of animals, so that its presence must be looked upon as normal, its absence as exceptional.

Colors are fixed or modified in animals by natural selection for various purposes: obscure or imitative colors for concealment; gaudy colors as a warning; and special markings either for easy recognition by strayed individuals, females, or young, or to direct attack from a vital part, as in the large, brilliantly-marked wings of some butterflies and moths.

Colors are produced or intensified by processes of development, — either where the integument or its appendages undergo great extension or modification, or where there is a surplus of

vital energy, as in male animals generally, and more especially at the breeding-season.

Colors are also more or less influenced by a variety of causes, such as the nature of the food, the photographic action of light, and also by some unknown local action probably dependent on chemical peculiarities in the soil or vegetation.

These various causes have acted and reacted in a variety of ways, and have been modified by conditions dependent on age or on sex, on competition with new forms or on geographical or climatic changes. In so complex a subject, for which experiment and systematic inquiry have done so little, we cannot expect to explain every individual case, or solve every difficulty; but it is believed that all the great features of animal coloration and many of the details become explicable on the principles we have endeavored to lay down.

It will perhaps be considered presumptuous to put forth this sketch of the subject of color in animals as a substitute for one of Mr. Darwin's most highly elaborated theories, — that of voluntary or perceptive sexual selection, — yet I venture to think that it is more in accordance with the whole of the facts, and with the theory of natural selection itself; and I would ask such of my readers as may be sufficiently interested in the subject to read again chapters xi. to xvi. of the Descent of Man, and consider the whole theory from the point of view here laid down.

The explanation of almost all the ornaments and colors of birds and insects as having been produced by the perceptions and choice of the females has, I believe, staggered many evolutionists, but has been provisionally accepted, because it was the only theory that even attempted to explain the facts. It may perhaps be a relief to some of them, as it has been to myself, to find that the phenomena can be shown to depend on the general laws of development and on the action of "natural selection," which theory will, I venture to think, be relieved from an abnormal excrescence, and gain additional vitality by the adoption of my view of the subject.

Although we have arrived at the conclusion that tropical light and heat can in no sense be considered the cause of color, there remains to be explained the undoubted fact that all the more intense and gorgeous tints are manifested by the animal life of the tropics, while in some groups, such as butterflies and birds, there is a marked preponderance of highly colored species. This is probably due to a variety of causes, some of which we can indi-

cate, while others remain to be discovered. The luxuriant vegetation of the tropics throughout the entire year affords so much concealment that color may there be safely developed to a much greater extent than in climates where the trees are bare in winter, during which season the struggle for existence is most severe, and even the slightest disadvantage may prove fatal. Equally important, probably, has been the permanence of favorable conditions in the tropics, allowing certain groups to continue dominant for long periods, and thus to carry out in one unbroken line whatever development of plumage or color may once have acquired an ascendency. Changes of climatal conditions, and preëminently the Glacial epoch, probably led to the extinction of a host of highly developed and finely colored insects and birds in temperate zones, just as we know that it led to the extinction of the larger and more powerful mammalia which formerly characterized the temperate zone in both hemispheres. This view is supported by the fact that it is among those groups only which are now exclusively tropical that all the more extraordinary developments of ornament and color are found. The local causes of color will also have acted best in regions where the climatal conditions remained constant, and where migration was unnecessary; while whatever direct effect may be produced by light or heat will necessarily have acted more powerfully within the tropics. And, lastly, all these causes have been in action over an actually greater area in tropical than in temperate zones, while estimated potentially, in proportion to its life-sustaining power, the lands which enjoy a practically tropical climate (extending as they do considerably beyond the geographical tropics) are very much larger then the temperate regions of the earth. Combining the effects of all these various causes we are quite able to understand the superiority of the tropical parts of the globe, not only in the abundance and variety of their forms of life, but also as regards the ornamental appendages and vivid coloration which these forms present.

THE SEVEN TOWNS OF MOQUI.

BY E. A. BARBER.

AS early as the year 1540, Don Pedro de Tobar, one of the first Spanish adventurers, was dispatched by Coronado to the "province of Tusayan" (the modern Moqui, situated in Arizona, in longitude 110° to 111° west, and latitude 35° to 36°

north). The inhabitants were filled with great fear when they heard that a race of fierce men who rode horses (never having seen such animals before) had captured Cibola (ancient Zuni). "They, however, made some show of resistance to the invaders in their approach to their towns, but the Spaniards charging upon them with vigor, many were killed, when the remainder fled to the houses and sued for peace, offering as an inducement presents of cotton stuffs, tanned hides, flour, pine nuts, maize, native fowls, and some turquoises."[1]

Resulting from this visit of the conquerors, the Moquis or *Moquinos* were afterwards converted by the zeal of the Franciscans, but in the year 1680 they apostatized, and after massacring their instructors revolted, together with other Indians of the territory then included in New Mexico. At that time they drove out the Spaniards from their towns, and no attempt, since that event, has been made to reduce them again to submission.

In the latter part of the last century, about the year 1799, Don Jose Cortez wrote of them: "The Moquinos are the most industrious of the many Indian nations that inhabit and have been discovered in that portion of America. They till the earth with great care, and apply to all their fields the manures proper for each crop. . . . They are attentive to their kitchen gardens, and have all the varieties of fruit-bearing trees it has been in their power to procure. The peach-tree yields abundantly. The coarse clothing worn by them they make in their looms. . . . The town is governed by a *cacique*, and for the defense of it the inhabitants make common cause. The people are of a lighter complexion than other Indians. . . . The women dress in a woven tunic without sleeves, and in a black, white, or colored shawl, formed like a mantilla. The tunic is confined by a sash, that is usually of many tints. . . . The aged women wear the hair divided into two braids, and the young in a knot over each ear."

Although the foregoing descriptions were written more than three quarters of a century ago, they apply to the tribe, in every detail, at the present time. During our visit to these strange and isolated people in the summer of 1875, I was struck with the accuracy of some of the early Spanish writers in their quaint accounts which I had previously read. The names of the seven towns are subject to shades of variation in pronunciation at different times, because the tribe possesses no written language by which they might be permanently recorded; yet it is a curious

[1] See Essay by Col. J. H. Simpson, Smithsonian Report, 1869.

fact that we can recognize the majority of these almost unpronounceable names in the most ancient Spanish chronicles. For the purpose of comparison I append the following lists as given by different authors at various periods: —

According to Don Jose Cortez, an officer of the Spanish Royal Engineers, in his report sent to the king of Spain in the year 1799: —

O-rai′-be.
Xou-go-pa′-vi.
Gui-paul′-a-vi.
Mos-zas′-na-vi.
Gual′-pi.

———

Tau′-cos or Tan′-os.

As given in the third volume of Pacific R. R. Reports by Lieut. A. W. Whipple, of the Corps of United States Topographical Engineers, in the year 1854: [1] —

O-rai′-be.
Shu-muth′-pa
Ah-le′-lah.
Mu-shai′-i-na.
Gual′-pi.
Shi-win′-na.
Te′-qua.

According to Maj. J. W. Powell, in his exploration of the "ancient province of Tusayan," in the year 1869: [2] —

O-rai′-bi.
Shong-a-pa′-vi.
Shi-pau′-i-lu-vi.
Mi-shong′-i-ni-vi.
Wol′-pi.
Si-choam′-a-vi.
Te′-wa.

As collected by the photographic division of the United States Geological Survey, which visited Moqui in the year 1875: [3] —

O-rai′-bi.
Shung-a-pa′-vi.
Shi-pau′-la-vi.
Mu-sha′-ni.
Mo′-qui or Gual′-pi.
Si-chum′-a-vi.
Te′-qua (pronounced *Tay′-wah*).

Mr. Wm. H. Jackson, the photographer of the United States Geological Survey, returned to the Moqui pueblos during the spring of the present year (1877), and while there, an actual census was taken with the following results: —

	Men.	Women.	Children.	Total.
O-ray′-bi	160	145	195	500
She-mo-pa′-ve	61	56	72	189
She-pau′-la-ve	33	29	46	108
Moo-song′-na-ve	69	67	103	239
Gual′-pi or O-pe′-ki	90	80	164	334
Se-chum′-e-way	35	31	36	102
Te′-wa	44	32	56	132
Total,	492	440	672	1604

On an examination of these figures we shall perceive that the percentage of males is larger than that of females, and this fact may be accounted for by the unadventurous and pacific character of the men. They are therefore less liable to accident than the males of other tribes, and consequently the two sexes of this tribe retain to a greater extent their normal ratio. Polygamy, therefore, is rare among them, and polyandry is unknown.

[1] Mr. Leroux, about the year 1853, estimated the Moquis at 6720 population.
[2] About the year 1870 Mr. Beadle gave the population of the seven towns at 3000.
[3] The tribe in 1875 numbered between 1500 and 2000 souls.

If we allow, out of the nine hundred and thirty-two adults, the large proportion two hundred and sixty to be unmarried, we will have an average result of only two children in every family. The mortality of the race being much greater than the increase in population (being about equally divided between the two sexes) the Moquis are rapidly passing away. In the last quarter of a century there has been a decrease of five thousand in their entire number. After the lapse of the next score or so of years the race will most probably have become extinct.

HUNTING AMBLYCHILA.[1]

BY PROFESSOR F. H. SNOW.

IN considering the unintelligibility of the title of this paper to one who is not a professional entomologist, I am reminded of a brief dialogue which occurred between Mr. Foster, a member of my last summer's collecting party, and a cow-boy of the plains, who passed by one evening while Mr. Foster was looking for specimens. After watching him for some moments with great curiosity, the cow-boy asked: "What you doing?" Mr. Foster replied: "Hunting Amblychila." The cow-boy, bewildered, inquired again: "Ambly Cheila,—who 's she?" "Who she is" it will be the object of this paper in some measure to explain.

In 1823 the famous entomologist Thomas Say discovered a single dead specimen of this insect "near the base of the Rocky Mountains." Twenty-nine years later a second specimen, also dead, was found by one of the United States surveying expeditions. The remarkable structure and extreme rarity of this beetle made it "*facile princeps*" among American insects, and its possession was eagerly desired and earnestly sought by our foremost entomologists. But many difficulties lay in the pathway of those who would gain the coveted prize. The regions in which the two specimens had been captured were practically inaccessible to the entomologist. No railroad had then entered the vast country west of the Missouri River, and hostile bands of Indians were at all times in readiness to massacre the reckless adventurers who should dare to traverse their hunting-grounds without a powerful military escort. A national expedition for

[1] Read at the annual meeting of the Kansas Academy of Science, October 12, 1877, by Professor F. H. Snow, of the Kansas University.

the survey of our immense unoccupied domains might obtain the needed protection by government authority. But what professional "bug-hunter" could hope for membership of such an expedition, — much less aspire to the requisite military escort for an expedition of his own for the sole purpose of hunting an insect, however rare and however valuable in the estimation of entomologists?

But notwithstanding the inaccessibility of the plains to collectors of insects, several attempts were made to overcome this difficulty. A distinguished American entomologist, not many years after the discovery of the second specimen of Amblychila in 1852, issued a circular containing a description and life-size figure of the beetle, and distributed it among the army surgeons at the various military posts in the Western Territories. Several additional specimens were in this way obtained, and several others were brought in by some of the more recent government expeditions.

But *Amblychila cylindriformis* continued to be the rarest and the costliest of American Coleoptera. It could hardly be purchased for museums at any price, and not more than two years ago no less than fifteen and twenty dollars were eagerly paid for a single specimen. Indeed, a price-list of North American Coleóptera, issued at Cambridge only eight months ago, quotes the subject of this paper at twelve dollars per specimen.

Two causes, however, have recently conspired to bring out the fact that this insect is by no means the same rarity in nature as in entomological collections. In the first place the removal of the Indian tribes from Kansas soil to distant reservations has made it possible for the collector of insects to visit the plains without incurring the imminent danger of losing his scalp; and in the second place the discovery of the crepuscular and nocturnal habits of *Amblychila* has led to the capture of great numbers of specimens during the past season. This discovery, which had been predicted by Dr. Le Conte, was actually made in the summer of 1876 by Messrs. H. A. Brous and S. W. Williston of the Yale College Geological Expedition to Western Kansas, in charge of Professor B. F. Mudge. The members of this party obtained about one hundred specimens. During the present season several hundred specimens have been taken by Messrs. Williston and Cooper of the Yale Expedition, and by the Kansas University Expedition in charge of the writer. It is more than probable that the present year has been unusually favorable to the

occurrence of this insect, and that subsequent seasons may prove, like the season of 1876, less productive of specimens. It is a well-known fact that a species may occur in abundance for a single year and then become comparatively rare or altogether unknown for several years in succession. This law will doubtless be found to apply to Amblychila as well as to other insects.

I was disappointed to find this insect apparently devoid of that intensely ferocious nature which had been ascribed to it by sensational writers for the Eastern press, and which would be suggested by its position at the head of a ravenous family of beetles, the *Cicindelidæ* or tiger-beetles. I have watched these insects night after night coming forth from their hiding-places soon after sundown and beginning their night-long search for food. I am satisfied that their sense of sight must be exceedingly deficient, as they never discover their prey from a distance, however slight, and never capture it unless stumbling upon it as if by accident. When, however, they do thus stumble upon an unfortunate caterpillar, grasshopper, or other suitable article of food, a very acute sense of touch, chiefly concentrated in their long and constantly vibrating antennæ, enables them to seize upon and firmly hold it with their powerful, strongly-toothed mandibles, while with their maxillæ or secondary jaws they withdraw the life-juices and soft tissues of their struggling victim. They also manifest the imperfection of their vision by making no attempt to escape from their human captors, allowing themselves to be picked up as if entirely blind.

They are slow in their movements, walking about with great deliberation over their favorite hunting-grounds, the sloping clay banks. The only approach to rapidity of motion observed during the summer was in the case of a single individual suddenly surprised by the morning sun while at a distance from a suitable hiding-place, which he was making frantic exertions to discover.

In a brief article contributed to this Academy at our last annual meeting it was stated by Mr. Brous that these insects "live in holes generally made by themselves." My own observations do not corroborate this statement. On the other hand I found them invariably coming forth at night from holes made by other animals, — most especially from the intricately winding burrows of the kangaroo rat (*Dipodomys Philippii*), by which the clay banks are often completely honeycombed. In these burrows they take refuge from the direct rays of the sun in the day-time, in company with other nocturnal genera, — Eleodes, Pasimachus,

etc. These latter insects undoubtedly furnish many a diurnal meal for Amblychilæ, which are not to be supposed to pass the day in sleep. On one occasion I had an opportunity of watching two of them in a large, abandoned badger's burrow. They were wide awake, and walking about with vibrating antennæ as if in search of food. I have also kept several living specimens in confinement for several weeks, but never discovered any disposition to make excavations for themselves, though they would gladly take possession of holes made for them in the earth at the bottom of their cage.

In regard to food, no living insect seems to come amiss to them. They seem to be especially fond of all sorts of lepidopterous and orthopterous larvæ. I have seen them seizing and devouring the huge wingless locusts (*Brachypeplus*) and the sword-bearers (*Ensicaudes*). I observed one individual in the act of conquering and devouring the large Prionus of the plains (*P. fissicornis*), and in two instances have seen them eating one another, apparently with the greatest relish. In confinement they will thrive upon full-grown maple worms (*Dryocampa alba*), the caterpillars of the handmaid moth (*Datana ministra*), and upon almost every other insect pest of the orchard and garden.

But while thus visiting the death penalty upon every member of his class with which he comes in contact, our voracious hero is himself a choice article of diet to at least one carnivorous quadruped of the plains. Mr. J. M. Walker, one of the members of my party, while patroling his accustomed beat one morning before sunrise, discovered the fresh fragments of several half-eaten Amblychilæ scattered along his route, as if some predatory animal had but just preceded him and made his breakfast upon the rarities which otherwise would have found their way into the collecting-bottle. On the evening of the same day, Mr. Walker, while collecting in the same locality, was violently attacked by a rabid skunk twice in immediate succession. The next morning Mr. Foster, the other student of the party, was similarly attacked on a neighboring clay bank, and had the good fortune to kill his assailant. An examination of the contents of the animal's stomach disclosed the remains of freshly eaten Amblychilæ. It would thus appear that this ill-odored quadruped has an original claim to the title of Amblychila hunter, and is ready at the proper time to vindicate the claim against human contestants. This fact will merit the serious attention of entomologists who may

hereafter visit the plains, since the bite of the rabid skunk has proved fatal to man in more than nine cases out of ten, and there are more than fifty fatal cases on record. In this connection may be mentioned another danger which must be incurred by the collector of insects upon the plains. I refer to the bite of the rattlesnake, which venomous reptile abounds in Western Kansas and Eastern Colorado, and was encountered nearly every day by some member of our expedition.

REMARKS CONCERNING TWO DIVISIONS OF INDIANS INHABITING ARIZONA, NEW MEXICO, UTAH, AND CALIFORNIA.

BY DR. EDWARD PALMER.

HAVING traveled extensively in that part of the United States acquired from Mexico, and having examined the so-called ancient graves and mounds, as well as studied the Indians now living in the same region, I have come to the conclusion that this region was formerly inhabited by two divisions or classes of Indians, distinguishable by their modes of burial — one burning, the other inhuming, the corpses — and by their dwellings and domestic arts. In the same region are to be found graves which do not belong to the Indians now living there, and containing either the bodies or ashes of human beings whose epoch we have no means of determining.

The Indians found in the city of Mexico, and said by the Spanish historians to offer up human sacrifices to their gods, were only observing their usual custom of burning their dead. The Spaniards killed them in great numbers, and the Indians in burning the dead afforded their enemies, the Spaniards, the grounds for notions out of which to make religious capital. So the priests and officers magnified this simple custom, and by declaring the Indians to be idolaters and sacrificers of human beings they did them a grave injustice.

The Spaniards in their conquests always kept in view the maxim that the means justify the end. To ascribe the burning of the dead to offering up human sacrifices to gods was sufficient to gain the desired object, as the church would be aroused at once to send out missionaries to convert the heathen and establish religious orders among them.

Concluding that the Indians found living in the city of Mexico at the time of the Spanish conquest were Aztecs or crema-

tionists, if we go to that part of the United States formerly composing the frontier provinces of Mexico we find at this day pure Aztecs or cremationists; for those of the same race in the thickly settled and richer portions of Mexico have by one means or another been compelled to change from burning to burying their dead. While in Arizona we have the Apache, Mojave, Yuma, and Cocopah tribes, and in Nevada the Digger, which burn their dead, in California the Indians have so changed by church influence that nearly all bury their dead according to the rules of the Catholic church instead of burning the dead. Part of the Daigano tribe, after the expulsion of the Jesuits from Mexican territory, moved to the border of Lower California, and have gone back to all their old customs, burning their dead, and are now Indians in every sense; that is, they are free and untrammeled by any encroachments of the white man or his fashions.

The other division of Mexican Indians were those who buried their dead. They had only to drop their own mode of disposal of the dead and adopt that of the Catholic church. In order to observe the Indians of this division with customs unchanged, we must visit the Puma of Arizona, the Moqui and the Yuma Indians of New Mexico, for the other bands of this division adopt the Catholic mode of burial.

The cities and dwellings of the two classes of people in the country at the time of the Spanish conquest must have greatly differed. Yet the Spaniards called them all Aztecs. In this there seems to have been a design. The dwellings and cities were so exaggerated as to size and importance that in reading the reports sent to the Spanish court and the Pope one is led to conclude that they were of a grandeur and magnificence beyond all conception. But for Indians at that day or this to live in such a high degree of civilization is out of the question. Neither the ruins of former cities nor the style of the present buildings of their descendants supports those extravagant assertions. The statements of the Spanish priests were sufficient to make the Spanish government proud of its acquisitions, and in return its officers and the representatives of the church received great honors and rewards. The Spanish historians of the conquest of the city of Mexico tell us that the city was built on a marsh or wet land; for they say that ditches were cut to drain the city, and boats run up and down them. But how could magnificent buildings of great height, built of large blocks of

stone, be supported on a swamp, and how could they transport such large masses from the distance they had to be brought, without draught animals, — for they had no horses until the Europeans entered the country. Engineers have decided, after careful examinations of the foundation of the ancient city of Mexico, that buildings of the size spoken of by the Spaniards could never have been supported upon a marsh, as the foundations of the ancient city prove to have been; besides, if they did exist, some fragments would be found, as they could not be so entirely obliterated that not even a vestige would be left unless the pieces of sculpture and the calendar stone, which have been dug up in the city, may be considered to have belonged to the ancient city of Mexico. They may have been the ornaments of a Toltec building, brought by the Spaniards from some of the large Toltec towns with a view of sending them to Spain to give color to their reports, but owing to the difficulty of their transportation to the sea-coast at that day were left to be cast away, and resurrected years after as Aztec remains. Now, taking this view of the subject, we are led to the conclusion that the ancient city of Mexico was a collection of small one or two story houses made of adobe or sun-dried bricks, or in some cases possibly built of upright poles with sticks braced between and mud plastered over them. This kind of a house is frequently met with at this day, for round poles, sticks, and straw are used with a covering of clay for a roof. The people were not to be despised for living in these kinds of dwellings; their neighborhood afforded no other building materials, and their descendants of to-day live in houses made of like materials. Indeed, what else could the Apache, Mojave, Yuma, and Cocopah Indians use so easily and quickly as earth and poles, sticks and straw? Houses built of these materials answered all their wants.

The second division of Indians, those that buried their dead, were the Toltecs, neighbors to the Aztecs or cremationists. The dwellings of the former were superior to the latter, being confounded with and called Aztec. The Spanish conquerors reported these habitations as magnificent, in order to magnify their conquests. As superior as were the buildings of the Toltecs over those of the Aztecs, yet they were not of the grandeur reported by Spanish historians. Considering the Pimo Indians of Arizona, Moqui, Zuni, and the Rio Grande Indians of New Mexico, to be of the Toltec division, with the exception of the Pimos they live

in three-story buildings, — several families in a building, — and form a marked contrast to the Aztec buildings of to-day.

The ruins in the same country convey the idea that a similar kind of buildings inhabited by this class of people existed many years ago. The Pimos formerly lived in large buildings of several stories, and a good many persons in a building, but the Spaniards entered the country, and waged war with their Aztec neighbors, the Apaches; at the same time the Pimos acquired horses and arms from the Spanish, which also assisted them in coping with their enemies. The Apaches being thus placed in a condition to leave their communal dwellings, their lands became worn out. They now settled on a new tract of land close to their old homes, building small houses suited to each family. The reason that Indians live in communities is for better protection from their enemies. There seem to have been in the past as in the present periods constant war between the two divisions of Indians. The Aztec sbeing the most numerous and warlike and without fixed habitations, were an enemy to be feared, very difficult to conquer, and so tenacious of their freedom that the priests had to resort to force as well as to persuasion before any could be gathered into the church fold.

The Toltecs, being settled in communities in order to protect themselves from the Aztecs, were more easily influenced by the priests, and now most of them have adopted more or less of the Catholic religion. Heretofore the pottery found not only in the ruins and mounds of the country under consideration, but that scattered on the surface in fragments, has been considered by writers as the workmanship of the Aztecs; but the fact is that formerly, as at the present time, this pottery is made by the Toltecs, or burying Indians, and it is identical with that made by the same division of Indians to this day; while the Aztecs make a very rude class of pottery, which gives the impression that they may have borrowed the art of pottery-making from their Toltec neighbors. It is rough and of inferior ornamentation. The Aztec is superior to his Toltec neighbor in the art of warfare, and is a more successful hunter; on the other hand, the Pueblo or Toltec surpasses him in the architectural magnificence of his dwellings and in his superior mode of tilling the soil, and also in his systematic form of government. The advent of Europeans, the acquisition of horses, the establishment of Catholic missions, and the introduction of fire-arms among the Indians were no doubt the cause of most, if not all, of the modern changes

wrought among them. Those gaining horses and arms were enabled to wage war against their enemies. The church, being in harmony with the military force of the country during the Spanish and Mexican occupancy of the same, would send out a force of soldiers or conquered Indians, with horses and arms, to war upon the different Indians who were considered enemies, killing the men and bringing in the women and children, who were baptized, and thenceforth lost their tribal relations. Great numbers were thus gathered around missions, which so weakened various tribes that they would unite so as to be able to cope with their common enemies, the church or an Indian tribe. Both divisions suffered by like causes; and when a band of each of the divisions united, the customs of one would give way to the adoption of those of the other, or each would carry out the customs of both according to inclination. For instance, the bands of Pai-utes will sometimes burn, at others bury, their dead, indicating that they are composed of both divisions of Indians. Or a band of each of these divisions of Indians may live side by side for mutual protection, and gradually adopt each other's customs, as is the case with the Maricopah Indians of Arizona, who soon after the Mexican war removed alongside of the Pimo Indians, for protection. Now they have nearly given up their custom of burning the dead, and adopted the custom of the Pimos, burying the dead. They have also improved in the art of making baskets and pottery, so that they can make an article equal to the Pimos.

It must be evident that the nature of the country which is occupied by a nation influences the manners, habits, and intelligence of the people. The ever-craving appetites of life, especially that of hunger, operating upon each individual cannot fail to give direction to his inventive habits, determine his pursuits, and impress upon him a character for all time. If the soil will yield grain or roots, or the rivers a plenty of fish, or if the mountains, valleys, and prairies are stocked with game, the course of an Indian's life day after day is thereby established permanently, for the wants of nature compel him to one fixed system of procuring food. The food question being all-powerful and not to be pretermitted, he is forced to become a hunter, a fisherman, or root-digger, in accordance with the nature of the country he occupies. Varied are the conditions of the soil and climate, as, for instance, that about the Moqui towns, which is so sandy and dry that they sow their seed so that it germinates in time to have the advantages of summer rains. All must stay

close to their crops to keep off rats or rabbits; for if their crops are destroyed, so dry and barren is the surrounding country that it affords few other natural products. On the other hand, the Apache lives in a country of mountains that yield game of all sorts, also seeds, roots, and fruit, with small but rich valleys in which he plants a little corn, wheat, etc. He need not stay close at hand to look after his crop, as nothing destroys it. He can roam and find plenty to eat until his crop is ready to harvest. Thus the Aztec is a wanderer, while the Toltec is a dweller in communities.

In comparing the asserted high civilization of the Indians at the period of the Spanish conquest with their present condition, we see a great difference, which can only be understood after taking into consideration the nature and productions of the soil, their want of domestic animals, cutting-tools, their means of cultivation of soil and their manufactures. One can come to no other conclusion than that the Aztec division in past years was the same as at the present day, with the exception of slight modification caused by wars and mixtures of the two divisions. The men of the Aztec division are lazier than those of the Toltec division, making their females do nearly all the work, while the Toltec takes a greater share of the work upon himself. The Aztec seems to have little power of thinking, makes no progress nor effort to amend his life, is fearless of death, bravely submits to his inevitable fate, and with stolid indifference awaits the swiftly coming doom of his people. The Spaniards made a mistake in confounding the two divisions. The Toltecs being the most industrious had more wealth and better dwellings, and were entitled to much consideration; but the Spaniards say less of them than of the inferior Aztecs.

The missionaries of the Catholic church, more than all other causes combined, changed the mental and physical condition of the Indians by humbling them to that state of servitude required by them to be members of that church: they broke their native pride, and those who succumbed to that degraded condition of settlers around a mission lost all self-reliance, so that at the expulsion of the Jesuits and the abandoning of the missions they were left helpless, their spirits broken; those who robbed them of their means of self-reliance had gone; after their homes and lands had been taken from them those who were left became an easy prey to the avaricious, who easily got them in debt, and then by a law of their own creating ever after held these people and their descend-

ants as peons or slaves, because they were never able to acquire money sufficient to liberate themselves. At the conquest Indians were slaves to the few, but afterwards to the many.

In admitting them to the church they were sprinkled, given a new name, and their hair was cut short. This seems the chief difference between the so-called Christian Indian and the so-called heathen Indian of that part of the country previously indicated.

In several parts of the country under consideration, ruins of dwellings and graves of both divisions of Indians are to be found side by side; especially is this the case in the valley of the Rio Verde, in Arizona. On the one hand are cave-dwellings, on the other stone buildings, in ruins. Who built up and occupied the caves, and who built and inhabited the stone structures? The Toltec division, which is proven by the articles found therein; the Aztecs waging war upon the Toltecs drove them from the valley and took possession. The Aztecs or Apaches claim them today, but do not now live in them, because their military enemies all around compel them to keep in the mountains. Recently they were by force compelled to move to reservations.

The Toltec dwellings in former times as now were built of sun-dried bricks or adobes if they were more easily made, but if stone was at hand then that was used, and when not broken into suitable sizes by natural causes stone hammers were used to reduce them. They were laid up regardless of joints; with either kind of materials they made very good houses. In this valley the Toltecs selected the best natural positions on elevated points, commanding a view of their fields below and of the surrounding country, so that they could not be attacked without a chance of seeing their assailants. The houses were generally of more than one story, and some appear to have been built with three.

In their graves with the dead is to be found pottery, etc., and about the dwellings is to be found much broken pottery of a quality that points to Pimo and Moqui origin.

The caves were used as dwellings during the summer, when they looked after their crops; but when the autumn set in fever and ague prevailed in the valley, the Indians removed to their houses, built of stone on the bluffs above the caves, safe from ague. The caves are natural excavations in the rocks, and well adapted for Indians' dwellings. The Aztecs drove the Toltecs out of this valley, and built themselves houses of sticks covered with straw and mud, a contrast to the large, airy dwellings in

the caves and the stone buildings on the bluffs. Many caves are to be found in the country, and they appear to have been occupied by the same people, the Toltecs. The Aztecs left many grave-yards, which are distinguishable by piles of stones, generally of a circular form, but with no regularity as to distance apart. In one, particularly, I noticed a number of graves arranged into some degree of order, being in nearly straight rows and several in a row, with stones piled on top lengthwise as if to indicate the height of the deceased when living; but in both these kinds of graves there was nothing beyond ashes and pieces of human bones placed nearly in the centre.

The ruined cities built of adobes in the provinces of Durango and Chihuahua, Mexico, are like the seven cities of Civola, or towns of the Pueblo Indians of New Mexico, mentioned by the Spanish, who speak of the great wealth of the people living in them; if they were formerly wealthy they are not now, and the quality of the soil must have changed and more water must have flowed over the surface. These people in early days had no domestic animals, so they must have depended upon the soil of their immediate neighborhood for whatever they possessed. Now it is a dry, sandy waste, and these people can scarcely obtain the plainest living, much less gain the wealth spoken of by the Spaniards.

The people of these seven towns, as all those inhabiting that section of country under consideration were called by the Spaniards Aztecs, despite the wide differences between them. They seemed to have no other idea than to make these people appear great, powerful, and wealthy, in order to gain the favorable consideration of their king, on the one hand; and to make them to appear great idolaters, offering up human sacrifices to their gods, on the other hand, to please the church. But I have not been able to find any indications of idols among them other than what they have derived from the missionaries. They have many dolls made of clay by the females for the children to play with, and for no other purpose, many of which have been taken away and called gods. I have seen them in museums marked as coming from these people.

The church has tried to impress upon the Indian mind a reverence for a Montezuma whom they were taught would come some day, if they were good; to rule them, and historians say he lived and ruled the city of Mexico. If he had been a great ruler, and the impression had ever been conveyed to Indians by natural

causes that he was to come in the future to rule over them, they would be likely to have a remembrance in some legend, but none of the Indians living in the section under consideration seem to know anything themselves regarding Montezuma. We are also told by historians that the Indians mount their house tops in the mornings and turn towards the east and look for Montezuma; this I have never seen, though I have visited several of their towns. In questioning the oldest, who are the most reliable, regarding Montezuma, in every instance I have been told that Montezuma was a Spanish not an Indian god; they knew nothing of him except what the Spaniards taught them. Among the Daigano Indians of Hot Springs, California, are two that remembered the first missionaries that came among them. They were then about half grown, and remembered well the events of that period, though they are now very old. Among the many questions I asked them was the following: What was your mode of burial before the Spaniards came among you? They answered, "We burnt our dead." Several others of the same place said the same thing. To the question, Do you know anything of Montezuma? the oldest two, as also several others, answered, "Not of ourselves, but the Spaniards told us about him. He is a Spanish god." On visiting a band of the same Indians living on the border of Lower California, and having with me a Spaniard as interpreter, on entering a house the first thing that he saw was a doll made of clay (Indian mothers make them for their children and burn them as they do earthern ware). He cried out, "There is Montezuma, the Indian's god." At this a venerable man rose up, and with anger in his face said, "No Indian god; Montezuma is Spanish god." On my questioning several of both sexes upon the same subject, all asserted that Montezuma was a Spanish and not an Indian god. Among the mission churches, rendered as attractive as possible to please the Indians, many strange customs and ceremonies crept into the form of worship. A special saint was created for the Indian's benefit, to watch over him. If he has benefited by all the church has done for him, then retrogression must have a new meaning. The influence of the church and the extensive system of intermarriage by the Spaniards have so changed both divisions of the race held under their dominion, that we have an amalgamated variety different from both and very inferior to either, especially to the Toltecs.

As to where the Indians came from that have in former days and do now live in the country acquired from Mexico I will not

say, but will only remark that the cremationists or Aztecs look like Japanese, while the Toltecs or burying Indians look more like Chinese, not only in similarity of features but in manners and customs. The reserved and uncommunicative disposition of both certainly indicate a common origin.

If a close study were instituted among all the present tribes of Indians in the United States and Mexico, proof would no doubt be adduced which would determine to which of the divisions they belong, the Toltec or Aztec, — if of pure blood or a mixture of the two; and if inquiry were made as to the causes which led to the unity, it might also lead to the conclusion that all the tribes are offshoots of the two divisions. Certainly the Mandans and the so-called mound-builders belonged to the Toltec, while many of the Texas Indians appear to be Aztec in their origin. May not all American Indians be Chinese and Japanese under another name?

The early Spaniards may be somewhat excused, perhaps, for many of their exaggerations. They themselves were not so advanced then in agriculture, architecture, and the domestic arts as they now are; and when they beheld a strange land with a new people so advanced, they, comparing them with themselves, concluded that the Mexicans were a great people, as they were considering their surroundings and tools and materials to work with. They were great, both divisions of them. The fault was in exaggerating their wealth so as to be the gainers thereby, and making them out to be what they appear not to have been, idolaters, so that they might excite the zeal of a religious denomination to locate among them and to force upon them a new set of customs which would be the cause of their degeneration. It could scarcely be expected of the early historians that they would study the Indian character with the view of ascertaining the particular differences between them, as they were looking at them with a view to their own reward, and without any consideration of the Indian's material welfare or history. Whether Aztec or Toltec, by far the larger number soon became hewers of wood and drawers of water for the mission establishments or for a few Spaniards. The latter made wealth at the expense of the lives of thousands of Indians of both sexes, who were worked to death in mines, on farms, and in various occupations. The great aim of the rich was to be idle and to compel the poor to labor to make them rich.

The efforts of the missions were to have the rich subservient to them, so that nothing could be done by them without the sanc-

tion of the church. So the church owned the rich, and the rich owned the poor. Thus it was until Mexico became a republic and the church lost its power. Since the United States acquired that part of the country under consideration the Aztecs and Toltecs have been left to choose their own manners and customs, except those that have already become peons, who were under the authority of their owners, and so remained until after the late war, when the Congress of the United States passed a law abolishing peonage or servitude for debt.

The published accounts by the early Spanish historians have been copied by most modern historians as if they could be anything but inaccurate; few imply even doubt as to the truthfulness of the accounts. But if they had visited the country and seen the nature of the soil, the climate, and natural productions at the present time, and then looked back at the Indian without modern tools, machinery, domestic animals, modern fire-arms, clothing, and introduced grains, etc., and left out of sight the Europeans and their customs, the historians would have copied much less from old authorities. The actual condition of the Indian and his surroundings before he was at all tampered with by Europeans, when impartially viewed, will compel any one to adopt different conclusions from the old chroniclers.

Let us consider the descriptions of what they are pleased to call Montezuma's palaces and his entertainments of Cortez and his followers. There is scarce a European monarch that could produce more pomp and extravagance. Only contemplate the feasts of the reported magnitude gotten up by the Aztecs! They could not have had houses large enough, nor is it possible for a rude people with their native resources to have obtained the variety and quantity of articles said to have been used by the reputed Montezuma to feed the Spaniards; it would take but a short time to eat out an Indian community, with only their native mode of farming; it would require more executive ability than is generally possessed by even the smartest of the Toltecs, much less the Aztec Indians, to carry on an establishment of the character of that attributed to the so-called Montezuma. Consider what it must take to feed the army of servants he is said to have had; then the wealth he gave to the Spaniards and that they took by force. One can come to no other conclusion than that the Indians have sadly degenerated since that time, for they could not bring forth food or wealth at this day as they are said to have done at the conquest. There is something unnat-

ural in an Indian, however great he may be, having so great a number of followers about him. Indian men especially are so adverse to servitude that it is doubtful if so large a number could be held for that purpose; they would revolt, and who could prevent it? These volunteer servants would belong to almost as many different families, and it is nearly a universal fact that if one of a family is offended with any one the whole family take sides with him. An Indian's family comprises all his relations; so all the relations and servants of the supposed Montezuma would form a powerful army to withstand.

To give a more truthful version would be simply to state that a large number of Aztec Indians lived in the city of Mexico at the time Cortez made his appearance. They were governed by a chief who had a few hangers-on, as all chiefs have; generally his relations lived around him. Chiefs of both these divisions under consideration are required to procure their own provision, that is, his wives and children do. A chief is estimated by his wealth. I have never observed anything like tribute or taxes being collected by a chief. Presents are not only given but received by the chiefs.

One thing is certain: both the divisions of Indians when one dies let him be either burnt or buried; everything that the dead possessed or his friends had, even to his clothing, is thrown upon him to be either consumed with him or be put with him in the grave. This is a great barrier to the accumulation of property, for not even money or ornaments, however valuable, are withheld from the dead. The living relatives march from the last resting-place of the dead or from their ashes with nothing. The dead have it all, and the living will not go near the spot again or mention the name of the dead; it is so with both divisions. This would warrant the conclusion that they care not to convey events to history. A great deal is said about historical representations on rocks. I have seen the present Indians make representations on rocks like the so-called hieroglyphics, and I have invariably been told by them that they were made only for fun, and had no meaning.

It is very difficult to reconcile the accounts given of the people living in the city of Mexico at the time of Cortez's appearance with any of the present Indians. One of two conclusions may be adopted: if the people of the city of Mexico belonged to either of the two divisions of Indians, then there has been wonderful degeneration among them; or possibly those found were a special

creation attended with all the wealth and display for the purpose of honoring the captors of Mexico, and destined to disappear as soon as the crafty conquerors had accomplished their object.

NOTES ON THE BREEDING HABITS OF THE GOLDEN-WINGED WOODPECKER.

BY DAVID A. LYLE, U. S. A.

ON the afternoon of May 6, 1877, as I was strolling among the trees in the lower part of the Armory grounds, at Springfield, Massachusetts, I heard the faint hammering of a woodpecker (*Colaptes auratus*). Listening intently for some moments to ascertain, if possible, the direction from whence the sounds came, I proceeded onward with the stealthy tread of the Indian, — learned long since in the wilds of the far West. After advancing in this noiseless manner for some rods, I again halted and turned my ear successively in different directions the better to catch the faint sounds made by the industrious feathered artisan. Again I heard the rapping, and satisfied that I was traveling in the proper course I advanced some distance farther in the same quiet manner, and upon listening attentively for about a minute I was rewarded by hearing the sounds much more plainly.

I now redoubled my caution, following the sound more and more slowly for fear of alarming the shy worker. At last, I directed my attention to three trees, in one of which I was convinced that the woodpecker was working. The muffled sounds indicated that the bird had already penetrated the trunk of the limb or tree in which the nest was to be made. Carefully I approached the first tree, and placing my ear in contact with the trunk I awaited a repetition of the hammering. Again I heard it, but no more audibly than before reaching the tree. I tried the second tree with better success, for by pressing my ear against the trunk I could hear the thumpings very distinctly indeed. Now I was sure that I had found my bird, which conclusion was strengthened by finding among the grass near the foot of the tree quantities of small, fresh chips which the bird had ejected from his newly located domicile.

These chips were scattered over quite an area in the vicinity of the tree. On stealthily retreating from the roots of the tree in the direction indicated by the chips, I saw the hole bored by the object of my search. It had been screened from my view

by some branches which were just leaving out. The hole was situated near the top of a tall stump of sugar maple, the upper part of which had been carried away by some wind-storm.

I laid down upon my back on the ground, in order to command a better view of the hole, and for fifteen minutes I neither saw nor heard anything. I suppose the bird had heard some sound. Patiently waiting during this time, I at last discerned the side of his bill near the lower edge of the hole. Then he raised his head a little, so that his side and bill were visible, and watched with this eye for nine minutes by my watch, remaining motionless during the whole time. At the end of this interval he dropped to the bottom of his hole and a minute later his head appeared; glancing warily around, he thrust it out and I saw he had a bill-full of chips; these were protruding on both sides from between his mandibles. With a flirting motion of his head, he scattered the chiplets in the air, and gazing around for a moment he disappeared in his hole.

This operation he repeated several times, always reconnoitring the vicinity before and after disposing of the chips brought up. A couple of boys passing just as he had thrown out a load of chips, he dropped to the bottom of his nest in haste, and not a sound was emitted for another fifteen minutes, when a part of his bill was again visible as he came up to see whether or not the enemy had withdrawn. Five minutes later he put his head out of the hole, glancing quickly in every direction. This series of observations lasted for five minutes, when he disappeared, and in an instant reappearing he emerged from the hole and perched upon a limb about a foot from it. Here he stood for five minutes more, though it appeared to be much longer, and then flew to a high tree about fifty yards distant, where he rested for a moment, and then vanished among the trees. The female was not seen upon this occasion. On May 27th the female was found incubating, and the male was seen upon a tree some distance away, apparently cheering her by an affectionate call.

On referring to my note-book, I find the following under date of May 27th:—

"A little over two weeks ago, my attention was attracted by the appearance of a second pair of these beautiful woodpeckers upon the trees in the Armory grounds. They were very shy, but were evidently pairing. The female would fly from tree to tree, where the male would follow her, uttering a peculiarly low, cooing, assuring cry. This note, or rather succession of notes, is

heard only during the mating season. Very early a morning or two later, I found them upon a tree, quite near together. The male was very demonstrative in his love-making. At short intervals, he would droop his wings slightly, spread his tail, nod or bow his head towards the female, first to one side and then to the other, all the while uttering his low love carol. She reciprocated his bows, bowing every time he did, but uttering no note that I could detect.

"The affectionate anxiety of this feathered Adonis to appear well in the eyes of his mistress seemed most ludicrous to the beholder, while at the same time there was such an air of loving tenderness and devotion in both his voice and actions that the sympathy of the spectator was at once enlisted for the success and happiness of so gallant though so awkward a wooer.

"This courtship continued for about one week, during which time the happy pair had fixed upon the site for their future home. This they located upon the dead limb of an elm, sixty feet from the ground. The tree stood at the side of a much-traveled road and near some shops. Here their troubles began.

"Again, the truth of the old adage 'that the course of true love never runs smooth' was vindicated. For in a tree near that chosen for their future nest resided a colony of English sparrows, whose pugnacity is well known. The paucity of leaves on the trees exposed the handsomely colored woodpeckers to the danger of discovery by their fiery little enemies, the moment they alighted upon their chosen limb. No sooner did our woodpeckers begin the operation of outlining the hole for the entrance to their domicile than they were furiously assailed on all sides by the enraged sparrows.[1] The woodpeckers would awkwardly dodge their blows and get on the opposite side of the limb, but the sparrows returned again and again to the attack, until the woodpeckers would seek safety in flight. Still the devoted pair did not despair. Time after time would they return and work a little while until discovered by their sharp-eyed enemies, when they would again take refuge in flight. At the end of a fortnight the leaves had come out sufficiently to screen them from the view of the sparrows, but as people and teams were constantly passing the tree, their shyness kept them retreating almost every few minutes. This morning I find one of them busy chiseling away at the hole."

[1] So it seems that the flicker is to be added to the long list of birds which these wretched interlopers attack and harass. Dr. Thomas M. Brewer has so long persisted in his denial of the facts, in the face of testimony no less explicit, that it is a question with me whether he will not pooh-pooh this away too. — ELLIOTT COUES.

A week later their arboreal home had so far progressed that they could enter and be screened from the view of their vexatious little enemies. Here they worked and delved — if I may be allowed the term — for another week to secure the proper depth. The ground for several yards around the tree was strewn with the tiny, white chips brought up at intervals and cast to the winds with that peculiar flirt of the head and bill which is characteristic of this avian family. About the middle of July, I found both parents busily occupied in searching the trunks and limbs of trees for larvæ and worms to feed their young. During and after the period of incubation, the familiar notes of this bird were rarely heard except very early in the morning. The first week in August both families of woodpeckers disappeared and have not been seen since.

RECENT LITERATURE.

COPE'S VERTEBRATE PALÆONTOLOGY OF NEW MEXICO.[1] — The present volume of nearly four hundred pages of text and upward of sixty plates comprises Professor Cope's final report upon the vertebrate palæontology of New Mexico to the Wheeler survey. The species here described and figured have in greater part been previously characterized in various preliminary papers published by Professor Cope during the last three years; they are here treated more in detail, with the addition of nearly one thousand excellent figures. The volume hence takes rank as one of the most important contributions to North American vertebrate palæontology that has yet appeared. Among the results attained are, as announced by the author, "the elucidation of the structure of the western slope of the Rocky Mountains and the plateau to the westward of them, in Northwestern New Mexico;" "the determination of the fresh-water character of the 'Triassic' beds in that region;" "the discovery of extensive deposits of the Lower Eocene, equivalent to the Suessonian of Western Europe;" "the determination of the faunæ of four periods, in basins which had not previously been explored, namely, in the Trias, the Eocene, the Loup Fork Epoch, and the Postpliocene of the Sandia Mountains." The number of species of extinct vertebrata "obtained during the season of 1874," and described in the present report, are "? Triassic, 4; Cretaceous, 13; Eocene, 87; Upper Miocene (Loup Fork), 30; Postpliocene, 2;" making a total of 136 species. The

[1] *Report upon United States Geographical Surveys West of the One Hundredth Meridian.* In charge of First Lieut. Geo. M. Wheeler, Corps of Engineers U. S Army. Vol. IV. Palæontology, Part II. *Report upon the Extinct Vertebrata obtained in New Mexico by Parties of the Expedition of* 1874. By Prof. E. D. COPE. 4to, pp. xii., 370; pls. xxii.–lxxxiii. Washington. 1877.

greater part of the remains on which this report is based were collected by the author himself, who thus had the opportunity of becoming familiar with their stratigraphical relations.

In discussing the character of the great Eocene plateau of New Mexico, first explored by Professor Cope in 1874, it is claimed that the Tertiary mammalian fauna originated through a migration from the southward, replacing the Mesozoic type of Saurians which had until then occupied the field. "New Mexico," he concludes, "was then no doubt the source from which the fauna of Wyoming was derived, and the extension of the Wahsatch [or Green River] fauna probably proved fatal to the latest representatives on the American continent of the dinosaurian and other reptilian forms of Mesozoic time."

The work before us is divided into three chapters: the first is devoted to the Fossils of the Mesozoic Periods and the Geology of the Mesozoic and Tertiary Beds; the second to the Fossils of the Eocene Period; and the third to the Fossils of the Loup Fork Epoch. The Mesozoic vertebrata described embrace a single species of fish allied to the *Mugillidæ*, a large crocodilian, and a large, "probably terrestrial" animal, "with powerful fore and hind limbs subequally developed," called *Dystrophæus viæmalæ*, of doubtful class affinities. The Eocene types include several forms known also from the Cretaceous and Tertiary, and the Lepidostoid genus *Clastes*, known thus far only from the Eocene of the Rocky Mountains. The reptiles are more numerously represented, and embrace turtles, crocodilians, and ophidians. Of the six genera of turtles three (*Trionyx*, *Dermatemys*, and *Emys*) still exist. The several species of crocodiles are referred (some of them doubtfully) to the existing genus *Crocodilus*. The only bird described (*Diatryma gigantea*) was of large size, the single tarso-metatarsal bone, by which it is thus far known, having a breadth at its proximal end "nearly twice the diameter of that of the ostrich. Its discovery introduces this group of birds to the known faunæ of North America, recent and extinct, and demonstrates that this continent has not been destitute of the gigantic forms of birds now confined to the southern hemisphere faunæ." It is considered as allied to *Gastornis* Hèbert of the Eocene of France. The mammalia of this period are numerous, amounting to fifty-four species. Of these, ten are referred to the order *Perissodactyla*, eight to the order "*Amblypoda*," thirty to his new order "*Bunotheria*," and three to the order *Rodentia*. Space will not permit of more than a brief notice of these groups, the affinities and characteristics of which, and their various subdivisions, are discussed in detail. The *Bunotheria* were abundantly represented during the North American Eocene, during which period they "fulfilled the functions of the existing *Carnivora*." While they agree quite nearly in structure among themselves, they differ in important particulars from the true *Carnivora*. They are described as varying from the size of a weasel to that of a jaguar. Some of the puzzling forms

here brought together were at first referred to the *Carnivora*, others to the lemurine *Quadrumana*, others to the *Insectivora;* others still have been supposed to have ungulate affinities, and others constitute Professor Marsh's order *Tillodontia*. Professor Cope considers that his order *Bunotheria* cannot be defined so as to separate from it the existing Insectivora. Under this ordinal name he hence includes the existing *Insectivora* as a suborder, and considers that further investigations will be necessary to determine the relations of the *Prosimiæ* to this order. The *Bunotheria* are divided into five suborders: *Creodonta*, *Mesodonta*, *Insectivora*, *Tillodonta*, and *Tæniodonta*, which subdivisions are regarded as not more heterogeneous than those of the *Marsupalia*. The affinities of the *Bunotheria* are very divergent. While the *Insectivora* maintain their typical characters, the Tillodonts show a certain kind of affinity with the Rodents, and the Tæniodonts present "a point of connection with the Edentates," — the first hint of relationship between this anomalous order and the other mammals. The Mesodonts are apparently related to the Prosimiæ and Quadrumanes, as are the Creodonts to the Carnivores. If these interpretations prove to be correct, we have in the Bunotherians an extensive early generalized group foreshadowing the later more specialized mammalian orders of the present day. To this group are referred many of the mammalian genera of the early Eocène of Europe, as well as the Wahsatch and Bridger faunæ of the early Eocene of North America.

The order *Amblypoda* is regarded as the most generalized order of hoofed mammals, "being intermediate in the structure of their limbs and feet between the *Proboscidia*, the *Perissodactyla*, and the *Artiodactyla*," which fact, "together with the small size of the brain, places them in antecedent relation to the latter, in a systematic sense, connecting them with the lower mammals with small and smooth brains, still in existence; and in a phylogenetic sense, since they precede the other orders in time, they stand in the relation of ancestors. It is doubtless true that the *Amblypoda* were the ancestors of all living ungulates, although no genus of the latter can yet be traced to any known genus of the former, such genera remaining for future discovery." The proportional size of the brain, as shown by Professor Marsh, in respect to the *Dinocerata* (referred by Cope to the *Amblypoda*) is more like that of reptiles than of mammals, and another reptilian feature is seen in the immovable tibio-tarsal articulation, — hints merely of a very remote reptilian relationship. Two suborders of this group are recognized, *Pantodonta* and *Dinocerata*. To this order is referred the genus *Coryphodon* Owen (*Bathmodon* Cope), several species of which are here described in detail, together with an account of the milk dentition.

The *Perissodactyla* are represented in the Wahsatch Eocene by comparatively few species, all of small size, but some of them were numerously represented in individuals. They belong chiefly to the genera

Orotherium Marsh, and *Hyracotherium* Owen (to which latter Cope refers *Orohippus* Marsh). *Hyracotherium* has several near allies, both in the Old World and the New, and is here treated not only as a Perissodactyl, but is considered as having ancestral relations to the Equine series.

Passing over the interesting Review of the Characteristics of the Vertebrate Fauna of the Wahsatch Eocene of New Mexico (pp. 269–282), we have space for only a very brief notice of the chapter devoted to the fossils of the "Loup Fork Epoch." Among these are described two species of tortoise (*Testudo*), and one bird referred to the genus *Vultur*. Of the mammalia three are Rodents, three Carnivora (one referred to *Putorius* and two to *Canis*, one of the latter, *C. ursinus*, as large as the black bear), one Proboscidian (*Mastodon productus*), four Perissodactyls, and eleven Artiodactyls. The latter belong chiefly to the cameline group (genera *Merychyus* Leidy, *Procamelus* Leidy, and *Phliauchenia* Cope) and partly to the peculiar deer-antelope type here referred to *Dicrocerus* Lartet (*Merycodus* and *Corsoryx* Leidy), a probable progenitor of the deer tribe (*Cervidæ*).

The Loup Fork beds have been commonly viewed as representative of the Pliocene of France, although their exact synchronism has been considered as doubtful. Professor Cope believes that the general facies of the Loup Fork fauna indicate an earlier age than this, and that the Pliocene of America remains yet to be defined. The Loup Fork fauna is characterized by an absence of fishes and crocodiles, from which it is inferred that the "formation is that of a marsh and not of a lake." The fauna has been studied at three widely separated localities in the region west of the Mississippi River, between the strata of which there is a near lithological resemblance, and the fauna collectively presents a common character as distinguished from that which preceded and followed. It is hence isolated alike from the Quaternary and the White River epochs. Only three of the genera have living representatives, one of which (*Canis*) also occurs in the White River beds.

In conclusion may be noted the growing tendency to a recognition of the generic identity of a considerable proportion of the Tertiary genera of North America with their European representatives of approximately corresponding age.

THE WILD FLOWERS OF AMERICA, PART II.[1] — The second part of the present work includes plates of *Iris versicolor* L., the common blue flag; *Rudbeckia columnaris* Pursh, the columnar cone-flower; *Viola sagittata* Aiton, the arrow-leaved violet, accompanied by a figure of *Carex Pennsylvanica* Lam.; and *Steironema lanceolatum* Gray, the lance-leaved loosestrife. The latter plant is more familiar to our botanists under the older name of *Lysimachia lanceolata*. The four plates are beautifully

[1] *The Wild Flowers of America.* Part II. Illustrations by ISAAC SPRAGUE. Text by GEORGE L. GOODALE, M. D., Assistant Professor of Vegetable Physiology, and Instructor in Botany, in Harvard University. Boston: H. O. Houghton & Co.; New York: Hurd & Houghton.

executed and quite equal to those in Part I., although none of the species in the present number are as picturesque as *Aquilegia Canadensis* L., previously figured. The plates of the loosestrife and the arrow-leaved violet seem to us to be most successful as far as the accuracy of the representation is concerned. The most beautiful plate is that of the iris, which could be surpassed only by nature itself, for, in the species of this beautiful genus, such is the delicate shading of the colors and the exquisite translucence of the standards and the stigmas that art, at the best, must fall a little short of nature. With regard to the figure of *Carex Pennsylvanica* which accompanies the *Viola sagittata* we would suggest that its botanical value would have been enhanced had a matured spike also been figured. The descriptive text is shorter than that in Part I., but in *Viola sagittata* and *Iris Virginica* Professor Goodale has found material for some very interesting remarks on cleistogamous flowers and insect fertilization. In the present fasciculus the plates are not stitched but folded in the cover. In this connection we must express the hope that the publishers will give the public the opportunity of purchasing extra copies of some of the plates for framing, as we can think of no more appropriate ornaments for a school-room or lecture hall than the beautiful plates of this series. — W. G. FARLOW.

GENERAL NOTES.

BOTANY.[1]

FERTILIZATION OF FLOWERS BY BIRDS. — From recent mention of this subject in Mr. Darwin's new work, and in a review of it by Dr. Gray in the *American Journal of Science*, and two notes in *Nature*, I conclude that but few instances are known in which birds visit flowers. In the United States Dr. Gray names honeysuckles and trumpet creeper, in addition to *Impatiens*, which Darwin gives on authority of others.

The ruby-throated humming-bird is common in this State and is frequently seen about our flower beds and in the green-house. I have often seen it visiting lilacs, phlox Drummondii, perennial phlox, portulaccas, petunias, morning-glories, roses, honeysuckles, snapdragons, fuchsias, and I think many other species of which I have made no note. Several of the above were given me also by the gardener, Mr. Cassidy. He also had noticed that the birds came in through the ventilators of the greenhouse in spring to visit the fuchsias, of which they seem very fond, but after spring flowers appear their visits are less common. Again they frequent the flowers in the greenhouse in times of dry weather. I have not made as many notes on this subject as I now wish I had, but I am quite sure it will turn out that they visit a large number of species of our wild and cultivated flowers. They visit them with much greater rapidity than is common with the honey-bee. — W. J. BEAL.

[1] Conducted by PROF. G. L. GOODALE.

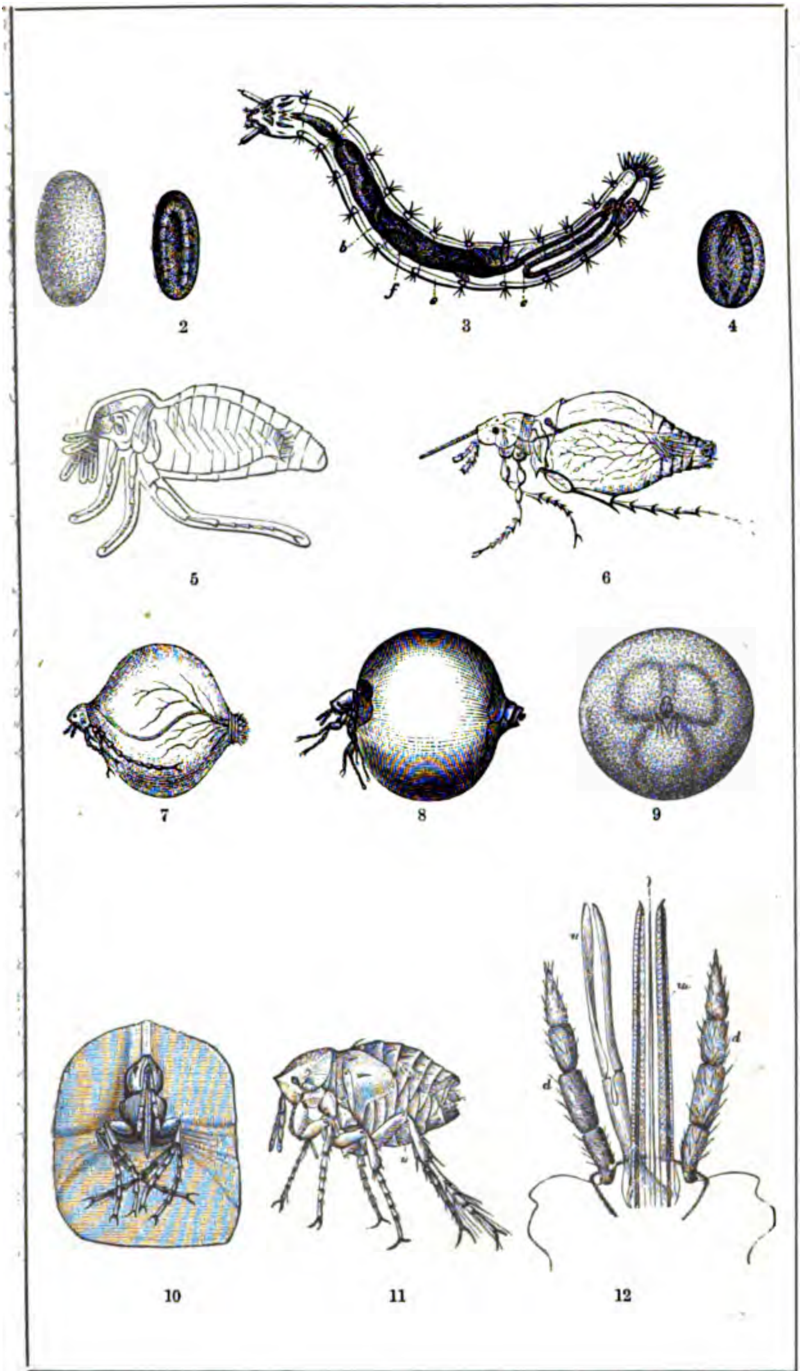

Plate III. METAMORPHOSIS OF THE JIGGER FLEA.

ZOÖLOGY.[1]

The Jigger Flea. — The jigger or chigoe, a species of flea (*Pulex penetrans*) which burrows in the feet of men in tropical America, has within late years been studied by Karsten, Guyon, and Bonnet. Our figures have been taken from these works, and were originally used to illustrate the Danish *Journal for the Popular Diffusion of Natural Science.* The eggs (Plate III., Figures 1, 2) are either dropped upon the ground, or remain within the sacs of the gravid female. The larvæ (Figure 3) transform in a cocoon (Figure 4) into the pupa (Figure 5), as in the ordinary flea. Figure 6 represents the fecundated female; Figure 7 the same at the third day from its entrance under the skin; Figure 8 the same after several days' residence in the skin of its host. Figure 9 represents the fully grown female, seen in front and magnified only four times; Figure 10, the head of the same still more enlarged. Figure 11 represents the female before it has entered the skin of its host, and Figure 12 the mouth parts, much enlarged (*w*, mandibles; *d*, maxillary palpi; *u*, under lip or labium).

ANTHROPOLOGY.

Anthropological News. — Some account was given in our last number of anthropological papers read at the American and at the British Association. The following are some of those communicated to the French Association: Déformations crâniennes occasionnées par la Syphilis héréditaire (discussed at great length), Parrot; Announcement of the Plans for the Anthropological Exhibition at Paris in La Palais du Trocadero (*Revue Scientifique*, No. 9, 1877, p. 204); Mémoire sur les Accumulations de Silex, M. de Puligny; La Nomenclature des Légendes anciennes, M. Daleau; Considérations sur l'Age du Bronze en Hongrie, M. Hampel; L'Age de la Pierre chez les Nègres, M. Hamy; Démographie de la Seine inferieure, Mariage, Natalité, et Mortalité, Dr. Bertillon; L'Homme à l'Époque du grand Ours des Cavernes, M. Ollier de Marichard.

GEOLOGY AND PALÆONTOLOGY.

Recent Palæontological Discoveries. — Professor Cope recently announced the discovery by Mr. C. M. Wheatley, in the trias of Pennsylvania, of a large saurian, which he named *Palæoctonus Appalachianus.* Since that time Mr. Wheatley has obtained material which demonstrates that the reptilian life of that period in the East was rich in types. This includes teeth of two other individuals of the saurian named, and teeth of six other species. Two of these, the *Belodon priscus* and *B. Carolinensis*, had been previously known, while three others of larger proportions are new to science. They have been named

[1] The departments of Ornithology and Mammalogy are conducted by Dr. Elliott Coues, U. S. A.

Clepsysaurus veatleianus, *Suchoprion cyphodon*, and *Palæoctonus aulacodus* by Professor Cope.

William Gurley, of Danville, Illinois, has recently added some interesting species to those already known to occur in the bone bed discovered by Mr. J. C. Winslow. Such are two new species of *Cricotus* (Cope) and an allied new genus, *Lysorophus* Cope. A second new genus is said to be allied to the salamanders, and is called *Diplocaulus*. Mr. Gurley finds also a new *Ctenodus*, *Orthacanthus*, etc.

Since his discovery of the *Camarasaurus* in Colorado, Mr. Lucas has obtained the bones of a number of other reptiles, some of them little inferior in proportions to the *C. supremus*. One of these, of herbivorous type, is described by Professor Cope, in the Proceedings of the American Philosophical Society, as *Caulodon diversidens*. A huge carnivorous species receives the name of *Lælaps trihedrodon* Cope, and a smaller type, with hollow biconcave vertebræ and neural arch united by suture is referred to the new genus *Tichosteus* with the name *T. lucasanus* Cope. A species of Emydoid tortoise without dermal scuta, and with solid plastron and marginal bones is called *Compsemys plicatulus*. It is the oldest of the order Testudinata yet found in North America.

GEOGRAPHY AND EXPLORATION.

Geographical News. — Among papers of interest in the forty-sixth volume of the *Journal of the Royal Geographical Society of London* are the following: On Mr. H. M. Stanley's Exploration of the Victoria Nyanza, by Lt. Col. J. A. Grant. The North American Boundary from the Lake of the Woods to the Rocky Mountains, by Capt. S. Anderson. The Valley of the Tibagy, Brazil, by T. P. Bigg-Wither. Notes of a Journey from the River St. Francisco to the River Tocantins and to the City of Maranhao, by J. W. Wells. The Water-Shed of Central Asia, East and West, by T. E. Gordon. Notes accompanying a Chart of a Portion of the Niger Delta, by R. D. Boler and R. Knight. There are several papers, by C. M. Watson, W. Ellis, R. Strachan, and C. C. Gordon, on the White Nile.

The Report of Progress of the Geological Survey of Canada for 1875–1876 contains an interesting Report on Explorations in British Columbia, by George M. Dawson, comprising observations on the physical geography and surface geology of the Pacific coast north of Washington Territory.

MICROSCOPY.[1]

Schrauer's Microscopes. — L. Schrauer, who has removed his establishment to No. 50 Chatham Street, New York, has just issued a new catalogue in which his stands are described and figured. They adhere more or less to the Continental model, and aim at thorough excellence in working qualities, without great display. They are essentially laboratory instruments, and among the best of their kind. They are fur-

[1] Conducted by Dr. R. H. Ward, Troy, N. Y.

nished with Hartnack objectives. Besides the manufacture of stands, Mr. Schrauer gives special attention to repairing microscopes and other scientific instruments. He also makes the common accessories, including the binocular attachment.

KEITH'S HELIOSTAT. — A new heliostat, designed by Professor Keith, is now made by Edward Kubel, of 326 First Street, Washington, D. C. It is an excellent model, simplified without loss of efficiency, and no doubt the best instrument for the use of microscopists who require direct sunlight, for photography, blue-cell work, or any other purpose. It seems a full substitute for the expensive imported instruments. Its cost is $50.00.

PROCEEDINGS OF SOCIETIES.

AMERICAN JOURNAL OF SCIENCE AND ARTS. — November. Introduction and Succession of Vertebrate Life in America, by O. C. Marsh. Note on the Helderberg Formation of Bernardston, Massachusetts, and Vernon, Vermont, by J. D. Dana. Is the Existence of Growth-Rings in the early Exogenous Plants Proof of Alternating Seasons? by C. B. Warring. (The foreign journals were not received in time to be noticed.)

BOSTON SOCIETY OF NATURAL HISTORY. — October 17th. Mr. C. S. Minot made a communication on the Unity of all Forms of Muscular Contraction.

November 7th. Professor C. Semper addressed the members on a Land Mollusk from the Philippines; Onchidium, and its Dorsal Eyes.

NEW YORK ACADEMY OF SCIENCES. — November 5th. A paper was read by Mr. A. A. Julien, entitled Observations on the Geognosy of North Carolina.

AMERICAN GEOGRAPHICAL SOCIETY. — November 8th. Rev. Selah Merrill delivered a discourse upon Modern Researches in Palestine.

SCIENTIFIC NEWS.

IMPORTANT NOTICE TO SUBSCRIBERS. — The AMERICAN NATURALIST will hereafter be published by Messrs. McCalla & Stavely, Philadelphia, Pa., and will be edited by A. S. Packard, Jr., and Prof. E. D. Cope, with the assistance of eminent men of science. The January number, with an unusually attractive table of contents, will be sent out to past subscribers, and it is earnestly hoped that all will not only renew their subscriptions, but induce others to subscribe. A little effort on the part of the friends of science will now insure the prosperity of this useful and attractive journal.

ERRATA. — Page 72, for Glivieri *read* Olivieri. Page 122, for Peruvian *read* Permian. Page 603, fifth line from bottom, for *carpus* read *tarsus*.

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